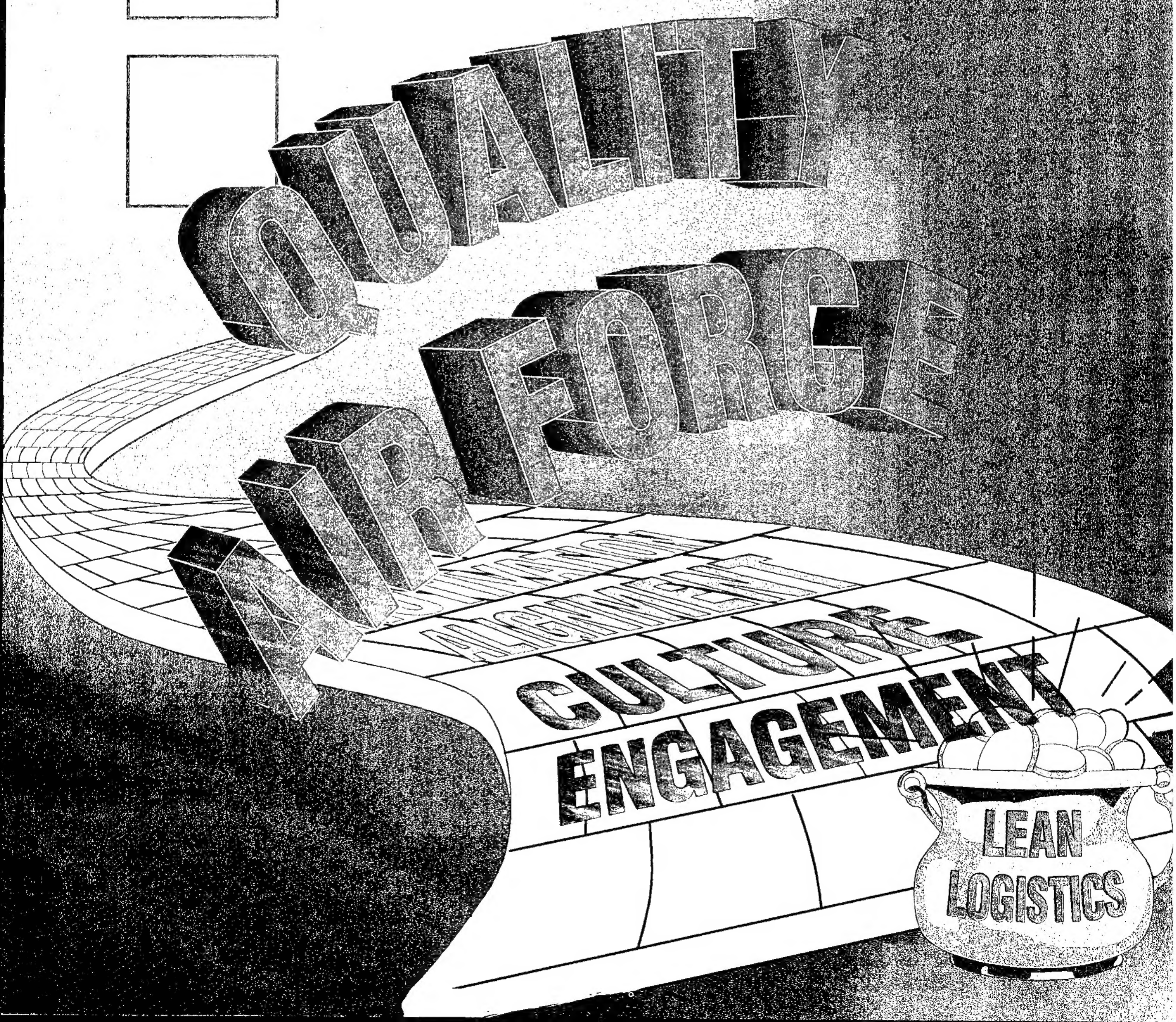
SPRING-SUMMER 1994

AIR FORCE JOURNAL of LOGISTICS



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When Good Enough, Isn't: Quality Air Force In Your Organization

Colonel Joe Boyles, USAF

Much has been written about the Total Quality Management (TQM) revolution that is slowly but surely gripping corporate America. The Air Force is no stranger to the TQM concept and has even coined its own term to describe modern management methods—Quality Air Force. While USAF antecedents to TQM are barely five years old, beginning in the former Air Force Logistics Command and Air Force Systems Command, they have certainly taken root. Today, an Air Staff Quality (QI) office serves as secretariat to the Air Force Quality Council. The Air Force Quality Institute located at Maxwell AFB, Alabama, serves as the focal point for quality, focusing on field support, research, and education. Recently, the SECAF Quality Award was established, using the Malcolm Baldrige National Quality Award criteria as its model. Throughout the Air Force, quality programs and their associated offices are springing up. It seems every bookshelf contains at least one well-thumbed volume written by Deming, Juran, Crosby, or Peters.

Despite this flurry of activity, TQM appears to be plagued more by myth than fact. Is it management or is it science? Why do so many well intentioned quality programs fail? Is it an indictment of the theory or our understanding? Let's examine these questions, and more, while learning how TQM can be implemented at the operational level. Along this journey, it is important to understand the factors which motivate leadership to begin TQM, the alignment or strategy of the approach, the culture which permits TQM to flourish, and the implementation or engagement phase. Finally, it is equally important to examine why most TQM efforts fail.

Motivation

Total Quality (TQ) requires leadership commitment and vision to takeoff and grow within the organization. What causes this to occur? Any number of factors may cause managers to embark on the TQ journey. Generally, these are significant factors because the journey is long and arduous—definitely not for the faint of heart. One factor could be the boss who insists on subordinates adopting his or her quality vision and transforming their organization. A motivating factor such as this is usually ineffective unless replaced by a more permanent motivator because bosses, be they commander, director, or division chief, tend to be transitory. Because the TQ journey is much longer than the incumbency of most leaders, this motivator is not sufficient to sustain the organization.

Some leaders feel change is necessary because they realize their organization is caught in a rat race. The paradox of a rat race is that when it's over, you're still a rat. Possibly, the motivator is to increase market share, or in a declining market, to preserve market share. This motivator could move many DOD organizations toward total quality as they face inevitable force drawdowns in the last decade of the 20th Century. Another motivator could be aggressive competition. Provided a business is not a monopoly, it is inevitable someone will find a better way to do business. Such motivation keeps organizations on their toes in a free market economy.

Another motivator could be the commander who wants to move his organization from being merely good to excellent, world class, the industry leader. And finally, there is the commander who is blessed with an overactive imagination, who can visualize things which don't exist and formulate a plan to move his or her organization in that direction.

Any of these characteristics, and possibly others, can inspire the commander to begin the total quality journey, as Dorothy from the Wizard of Oz puts it, to "follow the yellow brick road." The better one understands his motivation, the more committed he will be to the journey. This commitment serves to sustain the traveler along the rocky road which lies ahead.

Alignment

After the leader comes to grip with his motivation to embark upon the TQ journey, the next phase is alignment—the strategy and approach the organization will take to implementing total quality. Largely, this is a top-down directed effort. Organizational chaos will probably reign if the leader attempts to build the strategy from the bottom up. The leader must understand his motivation and be able to translate it into a vision. It is imperative that the alignment be based on well founded concepts, clearly defined, and effectively communicated to enable the organization to survive the buffeting caused by the transformation which lies ahead.

A total quality model, such as that in Figure 1, is a very useful tool in helping to organize the approach and explain it to the levels of management and workers who have a stake in the business' future.

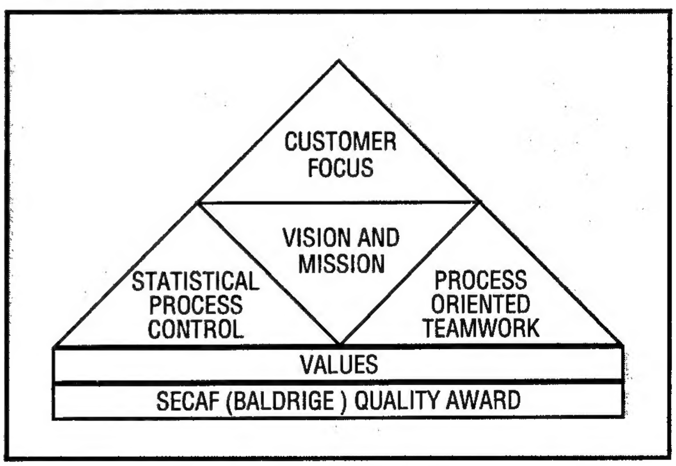

Figure 1. Total Quality Model.

The foundation of the model, and of any business, is its core values that the company stands for. Upon that foundation, the leader uses his or her vision to shape the mission. (1) The commander needs to equate the unit's mission with the Total

Quality program. Otherwise, TQ will be, at best, an add-on program to be accomplished if other priorities don't interfere. Three elements of total quality—customer focus, process oriented teamwork, and statistical process control are fundamental tools to successful implementation of TQ. The entire model rests on the foundation of the SECAF (Baldrige) Quality Award. The award is important because its criteria provides the organizational discipline upon which every critical TQ element rests. This award is different from the traditional paradigm of organizational awards. Whereas traditional unit awards are a litany of past achievements, real and perceived, a quality award such as Baldrige is future-based compared to a performance baseline. Every organization which competes for the SECAF Quality Award will improve.

Once senior management agrees on the best TQ model for their organization's future, they must recognize the obstacles which lie ahead. Generally, these obstacles fall in two categories: bureaucracy and cultural bias. (2) Bureaucratic roadblocks are the result of entrenched ideas from having done business by traditional methods over decades. A clear vision, logical strategy, and tenacious commitment by leadership will usually wear down the most stodgy bureaucracy. The second obstacle, cultural bias, is more difficult to combat because it is imbedded in the organization. In a sense, every person is a victim of this natural human failing. Figure 2 lists some of the more common attitudes which are characteristic of cultural bias.

Senior Management:

- Employees will take advantage of empowerment and make poor decisions
- Employees cannot interpret metrics
- TQM will not work in the public sector because there is no profit motive
- TQM costs too much, the payoff can't be defined
- There isn't enough time to accomplish both the mission and TQM

Middle Management:

- Will not sacrifice acquired authority
- No room for mistakes, the messenger will be shot

Worker:

- Never trust management, they won't empower

All:

- Customer complaints are bad news
- TQM is a fad, wait and it will go away
- Don't take risks, just do the job

Figure 2. Examples of Cultural Bias.

In order for TQ to become imbedded, rather than merely overlay the organization, cultural biases must be understood and overcome.

Administration of the Total Quality program is the next order of business. Initially, this is usually done best by an office chartered with responsibilities to manage the day-to-day details as well as the education program. In the mature phase, when TQ becomes second nature to the organization, the need for this office will probably scale back to training and education alone. While many aspects of TQ are common sense approaches to management, other concepts such as metrics, facilitators, and other TQ tools will likely be novel ideas to most of the work force. In order to achieve quality results, quality training must precede the engagement phase. Many organizations find that just-in-time (when needed) training achieves the dual purposes of current training, along with the important benefit of teambuilding. In addition to administration and education, the effective TQ program needs nurturing so that it is constantly in the limelight. Eventually, constant review of the program will become second nature to the organization which imbeds TQ in its business approach. Such was the case of a 1992 Baldrige winner, AT&T Transmission Systems Business Unit, whose CEO estimated that 30-40 percent of management's time was spent conducting TQ activities. (3)

A critical component of effective alignment is to focus on long-term improvements at the expense of short-term approaches. It sounds so simple, yet is so hard to do because people are creatures of short-term thinking. Most mistakes humans make are the result of "instant gratification," and businesses are no different. It takes tremendous organizational discipline to adopt the value of long-term improvement and then apply that value in daily business transactions. To compare and contrast this fundamental principle, what the short-term manager may see as a cost, the long-term manager will likely view as an investment.

Another fundamental transformation that should occur in the alignment phase is the organization's very approach to quality. Traditionally, organizations have defined quality assurance as the characteristics of the end product, in other words, after-work inspection. This approach is fraught with errors, both real and potential. A much more effective approach is in-process quality—building the product free of defects in the first place. Edward Deming says it best: "Cease dependence on inspection to achieve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place." (4:124)

Culture

The organization about to embark on the Total Quality journey must place high priority on transforming the culture of the organization for new, more progressive ideas to take root. Just as the farmer prepares his fields before planting, so must the leader prepare his organization to give TQ a fighting chance for success. Without this preparation, TQ cannot hope to imbed within the organization; at best, it will overlay.

Empowerment is the single most dynamic characteristic of the transformed organizational culture. Nothing will send so clear a signal as when management begins to divest itself of traditional power and disperse it throughout the work force. Nothing will break down the barriers of cultural bias, built up over years through traditional management methods, faster than empowering the work force. But empowerment is frequently misunderstood. Empowerment is no more worker anarchy than it is an opportunity for management to desert its responsibility. Instead, empowerment is a team approach to energize process owners to gain control and ownership over the work they normally accomplish. When this happens, workers quickly understand that a new day of management is dawning in the organization. However, this must be done in a measured approach. Empowerment without a clear charter and training is usually doomed to failure. Disillusion, after so much hope, will inevitably follow.

Another clear signal that the culture is changing is a revamped recognition program. Most existing recognition systems are

overly bureaucratic and represent management's clumsy attempt to reward individuals—good intention but poor execution. Management's first clue when they've missed the boat comes in the acceptance speech where the awardee often says, "I'd like to thank my coworkers without whose efforts this award would not be possible." A progressive organization will transform recognition programs to reward teamwork and peer acceptance. Employees can be empowered to accept this responsibility while management provides the means for recognition. At process level, workers know who is pulling his or her weight and who is not. Why not empower them and prove that their opinions not only count, but are appreciated? It is probable that, not only will the right individuals and teams be recognized, but productivity will collectively improve as the dynamics of peer pressure take over.

In the Byham and Cox book, *Zapp! The Lightning of Empowerment,* the authors discuss a powerful culture where workers are energized by progressive, understanding, and patient managers. The workers not only feel better about their work, but they transfer that energy to coworkers, customers, and suppliers. Of course, the opposite of Zapp is Sapp—stealing energy from others. Figure 3 gives examples of the Sapp and Zapp phenomen. (5:51, 56)

What Sapps People:	What Zapps People:
Confusion	Direction (clear key result areas, measurements, goals)
Lack of trust	Trust
Not being listened to	Being listened to
No time to solve problems	Upward and downward communications
Bureaucratic office politics	Support (approval, coaching, feedback, encouragement)
Someone solving problems for you	Solving problems as a team
No time to work on bigger issues	Responsibility
Not knowing whether you are succeeding	Knowing why you are important to the organization
Across-the-board rules and regulations	Flexible controls
A boss taking credit for other's ideas	Recognition for ideas
Not enough resources to do the job well	Resources readily available
Believing that you can't make a difference	Praise
A job simplified to the point that it has no meaning	Knowledge (skills, training, information, goals)
People treated exactly the same, like interchangeable parts	Teams

Figure 3. Comparison of Sapp and Zapp.

Continuing with the theme of culture, an enlightened leader, looking to transform his or her organization, will appreciate the important role of buy-in. A well-structured education and training program will improve the opportunities for buy-in. Not everyone learns at the same pace, and the TQ training program needs to be flexible enough to accommodate differences in learning speed. Buy-in is important because, the more people become committed to the change, the faster new ideas will spread. Thus, buy-in is not only part of the culture, but will serve to accelerate cultural change. Just like the effective politician, the leader must sell his ideas to implement and imbed them in the organization. Otherwise, they will overlay the business and last no longer than the leader's tenure. An important signal that the culture is changing is the way in which organizations and their leaders approach problem solving. For years we looked to the "lone ranger" as the organizational trouble shooter, moving from one location to another "putting out the fire." The trouble is that the solutions rarely prove to be permanent; invariably, the fires rekindle. Total Quality places far more emphasis on teamwork to solve problems discovered by critical process review and statistical process control. When management begins to approach problem identification and solution in this manner, another transformation has begun.

Values form the basis of an emerging TQ strategy. Basic values such as trust, integrity, and credibility are important ingredients of culture. When the work force sees visible examples of these values in practice by every management action, the cultural bias which separates management from supervision from workers will begin to erode. Positively, no other component carries more weight than values in serving to improve the foundation of a business.

Engagement

Once motivation and alignment are understood and the cultural transformation is underway, the organization is set for the takeoff phase—engagement. Up to now, any expenditures represent sunk costs and are best viewed as investment for the future. During the engagement phase, we begin to see pay back. The tools of Total Quality are put to use and the evidence of progress along the journey is apparent. As opposed to alignment, which is generally top down, engagement is from the bottom up, recognizing the importance of process knowledge which resides with process owners at the working level of the organization.

Key to understanding the engagement phase is a clear picture of the ingredients which make up the TQ formula. Figure 4 puts these ingredients into perspective.

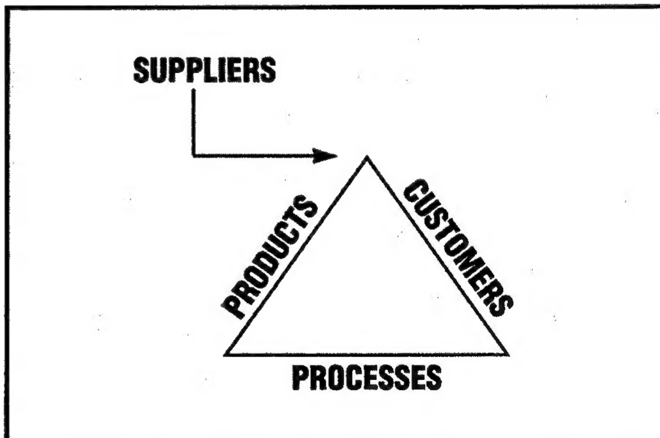

Figure 4. The TQ Triangle.

The picture of Total Quality at the engagement level is a combination of the suppliers, products, customers, and the processes which bring them together. A quality organization demands reliable, quality suppliers who provide the company with excellent raw materials, eventually to be converted into finished goods and services, the products of the business. Those products are destined for customers, the end result or mission of

the business. The conversion of those raw materials into finished products takes place in the processes of the organization. This last ingredient—process—is the most difficult concept to identify and the key to successful TQ engagement. From processes, the organization will be able to identify internal customers and the indicators which will enable process owners to determine whether or not the process is in control. The importance of this step—process identification—cannot be overstated.

As most process owners or work teams progress toward Total Quality, they realize the importance of both internal and external customer feedback and satisfaction. Surveys are often used as a tool to provide feedback and determine the level of customer satisfaction. At this step, good intentions often go astray. To be meaningful, surveys must be composed and controlled at the process owners' level. This is important because when customer surveys indicate a change is needed, only process owners can make a meaningful and lasting correction to effect change in the process. Process owners need to develop their surveys after answering two fundamental questions:

(1) What information do we want to know from our customers?

(2) What will we do with the data once we receive it?

Good answers to these questions are an excellent start to a quality customer feedback program. Armed with this direction, the data has both purpose and intended use. Since surveys are costly to develop and employ, it is important to spend scarce resources in a wise and prudent manner. Additionally, if the survey is well founded with regard to purpose and intended use, it is more likely that management will devote creativity to ensure customer feedback is captured in an effective and efficient manner.

One of the great joys in a blossoming TQ environment during the engagement phase is to see the multiplier effect as the concept catches on and spreads throughout the informal information (grapevine) network. Byham and Cox refer to this concept as the "lightning of empowerment"—workers energizing coworkers with the new concept, tools, and possibilities. (5:55) Another way to look at this phenomena is by visualizing an avalanche. At the top of the mountain, it begins with a very small movement of snow or rock. At the bottom of the mountain, that small movement has grown by order of magnitude into a significant emotional event. TQ can happen in an organization in much the same manner, which places even greater responsibility on an effective alignment phase. Without clear and concise values, vision, and planning, the TQ avalanche can quickly grow out of control and become a mound of rubble.

A truly world class Total Quality organization understands that good ideas or quality improvements reside at the process level and need to be liberated from the bureaucracy so they can be studied and, if worthy, adopted. It is important to understand that the only really meaningful improvement to the process comes from the process owner, the worker who has his or her hand on the daily operation of the process. Any other adjustments are probably nothing more than meddling. Leaders need to recognize the value of this approach and build mechanisms to encourage their use by the work force. In the business of a 1992 Malcolm Baldrige National Quality Award winner, AT&T Universal Card Service, this mechanism is known as the "10 Most Wanted Quality Improvements (QI)" program. (6) QIs are generated from the bottom (process level) of the organization. Each succeeding management level consolidates subordinate QIs into their 10 Most Wanted list until the entire firm has consolidated the ten most important problem areas to solve. Each level attacks their 10 Most Wanted list on a priority basis and holds elaborate "retirement" parties when a Most Wanted problem is solved and removed from the list. Imagine the empowering effect to a worker who has generated a QI, only to see it rise to the top of the list as the most critical problem an organization needs to solve for the long-term health of the business. Imagine the empowering effect when that idea is solved!

Probably the greatest TQ fear and subject of most myths is the area of metrics, made up of tools and statistical process control (SPC). A good name for this section might be, "A Monster Called Metrics." Most people shy away from statistics. If TQ is best described as management science, then metrics and SPC represent the science-side of the equation. In fact, the tools are relatively simple and, with properly applied education and training, can and should be learned and applied by workers at all levels. It is this last point, the level of application, where most mistakes are made and where metrics get an unfair rap. Before meaningful metrics can be applied, critical processes must be identified and understood. Because processes occur at the working level of the organization, metrics must be applied at that level so that they have meaning to the process owners. Once process owners have identified what they want to measure, they will probably need assistance from management in selecting the best tool to gather and portray the data. It is a shared responsibility, but it begins at the bottom of the organization. A common mistake occurs when management forces metrics on the work force. This top-down approach will likely measure the wrong factors or, more probably, have no real meaning to the workers. Metrics are meant to drive action at the process owner level, the only level which can make a meaningful change to the process.

Failure

What is outlined in this paper is a fairly simple and straight forward road map for leaders to follow as they start the transformation of their organization, but it is equally important to understand the pitfalls. A good strategy always includes analysis of what might go wrong; in that way, the leader can plan for ways to deal with trouble. There are many predictable traps for the organization as it embarks on the Total Quality journey. TQ experts tell us that 7 of every 10 organizations which begin the journey will fail to some degree. (7:15) Just like the marathoner, the organization will "hit the wall" and will be unable to progress further in its quest to become excellent. Why?

Some of these predictable traps have been mentioned in the preceding paragraphs. For example, a classic mistake is to embark on the journey toward Total Quality with an immature alignment phase, or possibly, no alignment whatsoever. Organizational chaos will surely be the result. Because TQ engagement requires decentralization, there must be a well conceived plan to ensure the decentralization is conducted in an orderly manner. Fundamentally, the organization and its leaders must understand **why** they are undertaking the journey, **what** they hope to accomplish, and **how** they intend to transform the organization.

Another opportunity for failure is poor commitment on the part of leadership. Lack of sincerity will be quickly identified by the work force. This will often result when the motivation is nothing more substantial than complying with the boss' desires or keeping up with the Jones. The squadron commander who puts together a TQ program only to meet the wing commander's desire is probably doomed to fail. Unfortunately, the hurt will

be primarily felt by the people who see their expectations rise, only to have hope and hard work dashed against the rocks. Have no illusions: TQ is hard work and involves persistent determination on the part of both management and workers. A lack of commitment will probably doom the effort, and it will die shortly after it is begun.

Many TQ efforts fail because the leaders and their organization cannot overcome the natural obstacles of quality: bureaucracy and cultural bias. For both of these obstacles, the best cure is commitment, primarily from leadership. Without commitment, many obstacles will be too tall and the organization will shrink from the challenge. In the case of bureaucracy, the leader must recognize that workers will encounter this challenge and will need help from management to overcome obstacles thrown in their path. When encountering cultural bias, the leader must be patient and appreciate that everyone learns at different speeds. By having a good strategy, repeating the theme, and emphasizing education, the most stubborn bias can be overcome.

Impatience works against Total Quality in more ways than one. By definition, the journey is long and arduous. The organization must concentrate on long-term planning and continuous improvement. Anything else will be superficial and quickly demonstrate to workers a lack of commitment and sincerity by management. Impatience can ground an otherwise solid TQ effort and cause it to fail. It is critical for leaders to visualize the journey ahead and continuously correct back to the path, despite all temptations to quit. Along these lines, it is important for the commander to not only chart the course for his two-year stint, but for future and succeeding commanders as well. Always remember that most workers and middle managers far outlast their leaders in the organization. Consequently, there will be times when the true leader must subordinate personal interests to those necessary for the long-term health of the organization. It is a mark of personal courage to follow such a course.

The last classic error made by many organizations which will surely cause a TQ effort to "hit the wall" is to engage from the top down. In most cases, the organization will catch this potential mistake during a thorough alignment phase. By engaging from the top down, workers will perceive that TQ is being imposed on them, and they will likely rebel. At best, most of the tools, such as metrics and process review, will be misapplied. Figure 5 places the phases of Total Quality in their proper perspective.

Conclusion

The Quality Air Force is here to stay. Although we might know it by different names, future quality principles will be similar to those practiced today. It is a mixture of management and science, holding great promise in reshaping business activities and the way organizations accomplish their mission. In squadrons and divisions, the basic building blocks of the Air Force, TQ can be used to improve a host of activities. For example, delivery times for a commodity can be shortened; defects can be reduced during a manufacturing process thus eliminating rework; improved sortie rates may be the result of a smoothed process; fewer errors on appraisal submissions may result in a more timely product. The list is endless, and only limited by our ability to empower and the imagination of our work force. Results are dependent on the foresight applied during alignment, but one result is positively guarantee—where Total Quality efforts are evident and genuine, morale will rise. (8) This fact alone should be ample motivation for leaders to accept the challenge and embark on the journey of continuous improvement. The "yellow brick road" beckons.

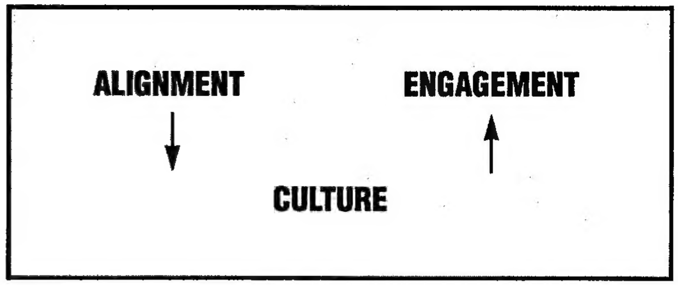

Figure 5. Perspective of Phases.

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Colonel Boyles is presently the Commander of the 65th Logistics Group at Edwards AFB, California.

USTRANSCOM Tests In-Transit Visibility (ITV) During Patriot Missile Deployment to Korea

Major Dean A. Smith, USAF

The "Year of In-Transit Visibility" is in full swing at the United States Transportation Command (USTRANSCOM), and the command's steady progress was put to the test recently with the successful Patriot missile deployment to Korea.

The Patriot deployment offered USTRANSCOM an opportunity to expand existing tracking capabilities to the maximum extent possible and to test new technology. This technology, known as Automated Information Technology (AIT), used beacon transceiver/satellite tracking of the Patriot missiles to Korea and demonstrated a definite improvement in visibility of the shipment while in transit. Transceivers are transmitters activated for transmission of a predetermined signal to a satellite for latitude/longitude cargo tracking.

The command used satellite tracking from locations in Texas, to final destinations in Korea. The mission began when the Military Traffic Management Command (MTMC), a USTRANSCOM component command, used its Defense Transportation Tracking System (DTTS) on special trains departing the army posts. With a computer interface, USTRANSCOM logged on to the DTTS and monitored the exact location of the Patriot missiles during the rail movement. In addition, this computerized system provided on-demand availability of a complete graphical mapping of all movements.

Problems

The entire process was not flawless, however, in its execution. Some problems surfaced which reinforced the fact in-transit visibility is only as good as the data used to provide that capability. The system was put to the test with the very first rail shipment. The satellite tracking showed one of the trains was already in New Mexico, but the local transportation officials thought the shipment had not even been released to the carrier. A follow-up on graphical mapping by DTTS revealed the train left before complete shipment data and documentation had been provided. After discovering this glitch, all other shipments departed with required documentation. (The documentation is critical as it ensures that operators and logisticians have complete and accurate data on shipment contents.)

Current DTTS limitations did not allow tracking the missiles all the way to Korea. Satellite DTTS has a limited footprint, mainly North America, North Atlantic, and Europe. This limitation was overcome as the Department of Transportation (DOT) stepped in to complete the tracking requirements during the last deployment stages.

The DOT used its INTRANSIT system which utilizes satellite beacons and the International Maritime Satellite (INMARSAT). The DOT INTRANSIT system, located at the John A. Volpe National Transportation System Center, Cambridge, Massachusetts, tracked the shipments from continental United States (CONUS) water ports to the final Korean destinations.

At the water port in Oakland, California, Volpe personnel put satellite tracking devices on the two ships departing with missiles. Volpe's computer interface enabled USTRANSCOM to log on to DOT's INTRANSIT system and monitor overseas movement. Tracking via satellite, with an update every six hours, enabled USTRANSCOM to determine that the ships would not meet the delivery date at Pusan at their current speed. The ships increased their speed and subsequently met the preplanned delivery times.

The tracking mission continued at Pusan when USTRANSCOM had Volpe personnel place beacon transceivers on each train and convoy departing the port. This allowed the tracking of several shipments simultaneously.

Lessons Learned

Several lessons were learned in the operation. For example, the command will explore ways to attach transceivers at the originating shipping location that will take them all the way to the final destination. They are also exploring direct integration of data into management information systems, such as USTRANSCOM's Global Transportation Network (GTN), that will allow customers anywhere to access the location of shipments. GTN provides an integrated transportation data system necessary to accomplish global transportation planning, command and control, patient movement, and in-transit visibility of units, passengers, and cargo during peace and war. USTRANSCOM is waiting for inputs from various GTN users to complete the evaluation process.

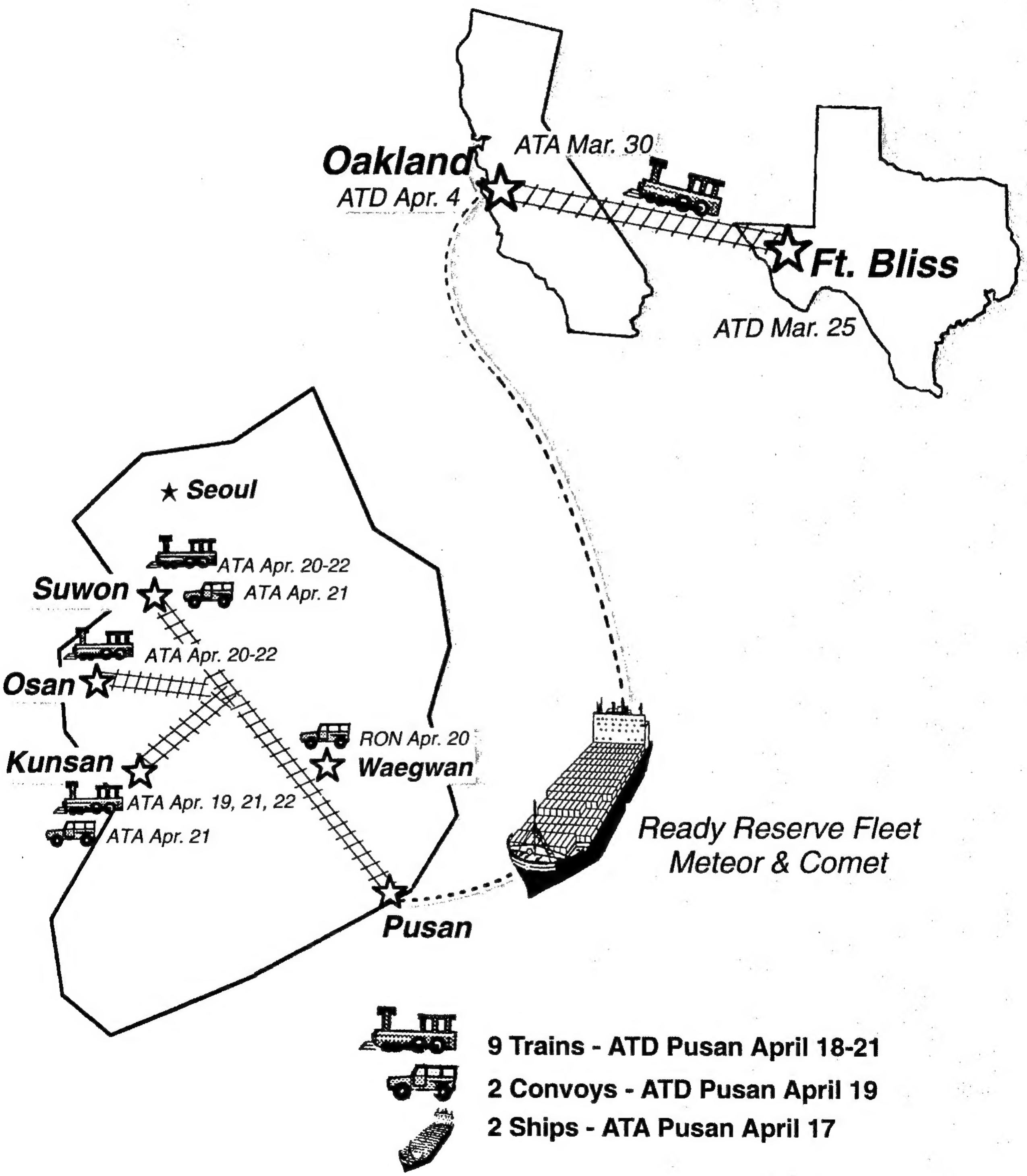
Summary

The use of satellites in tracking transportation movements provided the ability to monitor assets and provide almost instantaneous shipment location visibility. The Patriot missile deployment proved the importance of a reliable in-transit visibility capability. USTRANSCOM will continue to test this technology in other operations where tracking transportation movements are necessary and often critical.

USTRANSCOM is committed to working with the transportation industry and other DOD activities to enhance in-transit visibility for all its customers.

Major Smith is a team member on the Functional Process Integration Team, Transportation Management Division, HQ USTRANSCOM, Scott AFB, Illinois.

RESULTS OF KOREAN PATRIOT MISSILE DEPLOYMENT



Lean Logistics: Its Time Has Come!

Colonel Arthur B. Morrill III, USAF

Introduction

Some might suggest the most profound changes imaginable in our Air Force resulted in our operational wings being restructured. While these were undeniably far-reaching changes, others might conclude that **from a logistics perspective, even greater changes are those affecting and improving our core logistics processes and capabilities.** Lean Logistics is a system of innovations that does just that. With this in mind, I'll address three components of this evolving Air Force logistics environment—change, challenge, and opportunity. The section regarding on-going *change* highlights key initiatives under the "Lean Logistics" umbrella. Under *challenges,* I'll emphasize the need for logisticians to vigorously pursue continuous improvements in all aspects of the logistics arena. All of this leads to *opportunities* for all logisticians as we end this century.

A New Era of Change: Lean Logistics

Lean Logistics is an interrelated series of logistics initiatives that promote combat capability, enhance our war fighting sustainability, shrink the logistics footprint, and reduce infrastructure. **The goal: To enhance combat capability while reducing the annual operating costs of Air Force systems by adopting state-of-the-art business practices and streamlined processes, and by reducing infrastructure throughout the Air Force logistics community.** There are three ground rules. First, readiness and system availability are "benchmarked" at required Air Force rates to meet two nearly simultaneous, major regional conflict (MRCs) or peacetime commitments—whichever are higher. Second, Lean Logistics business practices and processes are applicable and effective in peacetime and during contingencies, in CONUS and overseas. Third, logistics infrastructure reductions achieved by Lean Logistics allow the Air Force to operate effectively with fewer resources, while sustaining force structure, peacetime operations tempo and combat readiness. How does Lean Logistics change our current approach to logistics? Figure 1 helps illustrate the improvements.

CHANGING THE LOGISTICS BUSINESS

TODAY'S LOGISTICS	LEAN LOGISTICS
· CHARACTERISTICS · BIG INVENTORY · SLOW/UNCERTAIN TRANSPORT · CUMBERSOME BATCH REPAIR · STATIC PROCESSES · HIGH COST	· CHARACTERISTICS · SMALLER INVENTORY · HIGH VELOCITY/ RELIABLE DELIVERY · OPTIMUM REPAIR FLOW · CONTINUOUS IMPROVEMENT · REDUCED INVESTMENT
· BASE PROCESSES: LARGE CAPITAL INVESTMENT · BIG PEACETIME OPERATING STOCK (POS) · BIG READINESS SPARES PACKAGES (RSP) · BIG FOOTPRINT	· BASE PROCESSES: LEAN TWO-LEVEL MAINTENANCE · SMALLER TAILORED STOCKS · STREAMLINED SUPPORT PACKAGES · LIGHT FOOTPRINT
· BOTTOM LINE · BIG INVENTORY DRIVES INFRASTRUCTURE	· BOTTOM LINE · INNOVATIONS STREAMLINE INFRASTRUCTURE

Source: HQ USAF/LGM2

Figure 1. Changing the Logistics Business.

Our first foray into "leaner logistics" and enhanced readiness was Two-Level Maintenance (2LM), which now holds the prominent position in the Lean Logistics architecture. Two-Level Maintenance is an Air Force initiative that was implemented on 1 October 1993 via a phased-in schedule after a series of convincingly successful tests. It's important because it improves the operational focus while reducing the Air Force's mobility footprint and costs associated with supporting Air Force weapon systems. It does so by improving the "tooth-to-tail" ratio, for example, by converting selected avionics and engines from three to two levels of maintenance. This conversion reduces intermediate-level maintenance requirements, thereby permitting reductions in base-level maintenance and support personnel, equipment, and facilities. Personnel savings are achieved by reducing 4,430 manpower positions Air Force wide from intermediate maintenance. Equipment purchases and maintenance are also reduced by ten percent over the Five Year Defense Plan (FYDP). Today, serviceables move in accordance with their Uniform Material Movement and Issue Priority (UMMIP) and the Required Delivery Date (RDD). They do not move expedite just because they are 2LM. **However, readiness is maintained under 2LM by controlling and streamlining all aspects of the repair pipeline.** Broken parts move from bases to repair centers at Air Force depots and then return to the bases, all at "high velocity" via highly reliable transportation. In doing so, depot repair centers combine 2LM work with existing depot repair capabilities. Finally, 2LM not only saves resources, but it also enhances our ability to support contingencies by reducing the "mobility footprint." Two-Level Maintenance relieves us from deploying intermediate repair equipment—in an F-16 squadron, more than 100 tons of engine maintenance and avionics equipment! We're also relieved of the need to put as many avionics and engine technicians in harm's way.

What makes this streamlining possible? Two Level's daily, time-certain delivery and return of critical spare parts. Daily time-certain delivery will use the commercial infrastructure in the continental United States (CONUS) of the Civil Reserve Air Fleet (CRAF) express carrier in peacetime, and the Air Mobility Express (AMX) during contingencies. Air Mobility Express is the military adaptation of commercial overnight delivery. It consists of the express carrier's CONUS infrastructure, Air Mobility Command aircraft (CRAF carrier or organic) and a rapid theater distribution system for express two-way movement within the theater. The Air Mobility Command will provide daily round-trip direct service between the express carriers' CONUS hubs and the designated aerial ports of debarkation (APODs) in the theater of operations. The theater commander must consider establishing a distribution system that provides next day delivery of critical cargo.

The elements that make Lean Logistics initiatives invaluable to warfighters are high velocity transportation and the highly reliable transportation of parts in peacetime

and during conflict, in CONUS and overseas. In fact, these components serve as the foundation for the Air Force's increasing use of modern business practices such as just-in-time (JIT) inventory and AMX. The Lean Logistics "Building" in Figure 2 illustrates the relationships.

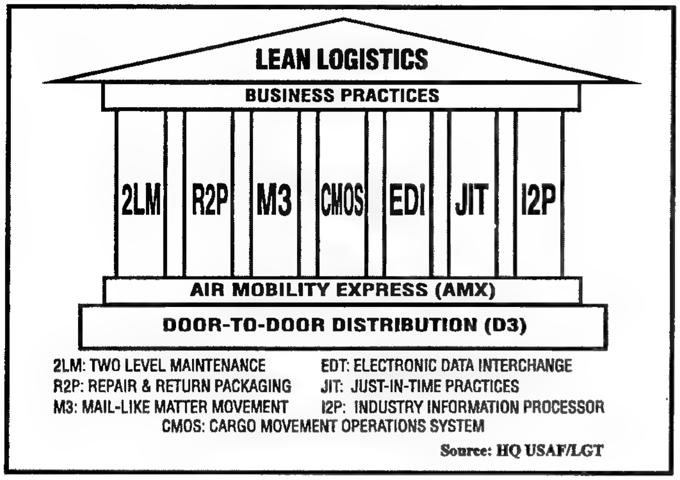


Figure 2. The Lean Logistics Building.

While a number of other Lean Logistics initiatives are still in varying stages of development, two other initiatives already implemented deserve mention. They are Door-To-Door Distribution (D^3) and Repair & Return Packaging (R^2P). You'll recall that LOGAIR was an integrated system of contract aircraft and trucks established to expedite the movement of reparables to, from, and between Air Force bases and their supporting depots. Budgetary and force structure changes prompted us to look at LOGAIR's effectiveness. As a result, we established the LOG EXPRESS Tiger Team to study LOGAIR and its alternatives. We found that while LOGAIR cost $116 million annually, D^3 cost only $41 million per year! Door-To-Door Distribution uses commercial premium express transportation for high priority cargo, and surface transportation for routine, hazardous, oversized, and classified cargo. In short, D^3 is more bang for the buck—it costs less, yet it's more responsive, efficient, guaranteed, and on-time.

Another key Lean Logistics initiative changing the way we do business is R^2P. **Implemented in conjunction with 2LM, R^2P works to increase the movement velocity of critical spares (high value, short supply) by minimizing the number of physical handling nodes, thereby entering the spares into the transportation and repair pipeline sooner.** In brief, the Air Force adapted the successful business practice of "return labeling," which was pioneered by the mail order industry. This initiative features the proven commercial business practice of pre-addressed return shipment labels. Aside from higher velocity movement of critical spares, its benefit is that commercial express carriers provide system equipment to create all shipment documentation. Another plus is that no capital investment is required for additional shipment hardware—a double bonus! Furthermore, payment of transportation costs are direct-billed to the appropriate Defense Business Operations Fund (DBOF) area of expense and not Operations & Maintenance (O&M).

The magnitude of change that could potentially result from these and other Lean Logistics initiatives is awesome for some, perhaps intimidating for others. For example, some logisticians may be concerned that with initiatives such as 2LM, base-level operational maintenance is on the verge of extinction. Others may believe that with Base Realignment and Closure (BRAC) Commission-induced Service depot closures, the Services' organic depot maintenance may also be on the wane. Neither conclusion could be further from the truth since maintenance capabilities in both of these areas will continue to be integral to preserving and enhancing our Air Force's global reach and power—either as a stand-alone capability, or in concert with other Services, joint activities, or the private sector. In short, this new era is one in which opportunities for logisticians should be seen as growing . . . not shrinking.

The Challenge to Logisticians: Embrace Innovation

The challenge this new era in logistics poses makes it critical that Air Force logisticians chart the course of Air Force logistics in the coming years by encouraging innovation and by leading the effort to implement continuous improvements to business practices and logistics processes.

Does this increasing focus on continuous improvement mean we should automatically discard current Air Force business practices and logistics processes? Absolutely not! We should evaluate what we do, consider why we do it, assess what it gives us, and determine if the output is worth the input given today's security requirements and resource limitations. Then, if change is needed, we should look everywhere—anywhere—for a better way to do the job at hand and the job we expect to do in the future. Continuous improvement means studying what works, what doesn't, why, and under what conditions. It may even mean looking to non-traditional sources for answers to traditional problems—something we're increasingly doing. For example, what Air Force logistician would have thought ten years ago that the commercial mail order industry's "return labeling" business practice would help us develop the Repair & Return Packaging concept that we now have begun to use to support Air Force weapon systems at reduced cost?

Where do we go for inspiration? What areas are ripe for examination from the macro and micro perspectives? There are several disciplines and principles that are likely sources of innovation affecting Air Force logistics practices and processes. A short list of such disciplines might include industrial engineering or public administration. A like list of useful principles might be those that increase user control and reduce user costs while delivering a certain level of product quality or capability. Examples of this latter group might include just-in-time practices, improved "make or buy" decision trees, streamlined commodity management, and flexible manufacturing and repair processes. The point is this: Whether we apply an entire discipline or just one principle, we're only just now discovering our capabilities for improving our logistics practices and processes—and logisticians should be at the forefront of this discovery. But, while this discovery should be unconstrained, it should also be focused—and leadership is the key.

Opportunities for Leadership: The Benefit of Innovation

With the restructuring of our operational wings and reduced defense budgets come great opportunities for logisticians to exercise leadership at all levels by fostering and implementing innovation in every area of logistics. Such leadership opportunities come with the prerequisite to expand one's experience base and develop one's professional skills. Foremost, this

(Continued on page 15)

A Day in the Life of a Munitions Officer

Captain Carey Tucker, USAF

"Chief, how in the world will we ever do all of this?" the harried young Captain asked his experienced guide. "The commander wants a draft copy of the convoy plan ASAP. We only have a week left to complete the semi-annual inventory. The flight line's squawking for more BDU-38s than they scheduled. We have a local NSI [Nuclear Surety Inspection] on our vehicles tomorrow. The cops are questioning our new security procedures. CE [Civil Engineering] and Safety are coming out to look at the missile maintenance shop at the end of the week. The PRP [Personnel Reliability Program] meeting is this afternoon. And now headquarters wants to talk shipments."

The wise old Chief just grinned at the young Captain, for he'd known this time would come: the time when a young Captain begins the voyage into the ranks of AMMO-hood. There is a coming of age for officers dealing with munitions and this Captain has reached that point. While the Captain may think there is an overwhelming need for a super-hero (Captain AMMO maybe), he or she is just encountering life "behind the fence;" a fertile training ground for future Air Force logisticians.

Lessons Learned

It is important for the Air Force to have fully trained munitions officers in the field. Lessons learned documented from recent conflicts, Vietnam and Desert Storm, reflect the concern with the eroding experience of officers in the munitions area. (1:63)

This concern is justified. Officers in the munitions field must not only be knowledgeable of all the major disciplines associated with logistics—maintenance, supply, transportation, and planning and control—but should also have a much more in-depth knowledge of security, civil engineering, safety, and personnel than most officers in other logistics positions. From looking at the responsibilities of munitions officers in different MAJCOMs or the AFI 21-200 series (Munitions Maintenance), it is apparent a wide range of logistics skills is necessary for successful performance.

Munitions Officer Roles

The Maintainer

Just as their counterparts on the flight line and in backshops, munitions officers are in charge of personnel who maintain and inspect assets. These actions entail scheduling. Munitions managers must not only concern themselves with the schedule of their workers, but they also need a good working knowledge of flight line scheduling since that drives many of the day-to-day activities in the munitions storage area.

Inasmuch as most of the troops in the munitions arena are inexperienced when it comes to flight line maintenance, it falls to the munitions officer to fill the void between what happens on the flight line and what happens in the storage area. The officer must make sure there is a strong working relationship between the flight line and the storage area. There are old "war stories" of problems between the two, such as the flight line sending a missile back with the only written discrepancy being "Bad missile," and the missile maintenance section responding with "Counseled missile, returned to duty." A strong relationship between the munitions personnel and their flight line counterparts will keep the communication flow open.

The Supplier

The munitions storage area operates its own mainframe inventory and accountability system, known as the Combat Ammunition System (CAS). CAS has three levels, A for the Air staff and depots, B for the base level, and C at the commands. In addition, a deployable CAS-D is under development. Munitions officers, particularly those with the responsibilities of being the Munitions Accountable Systems Officer (MASO), must be deeply involved in the operations of the CAS-B and understand the basics of the Air Force supply system.

Just as the logisticians in a supply position, the munitions officer must be knowledgeable of accountability procedures for serviceable and non-serviceable assets. Rules on the storage of munitions property are even more specific for the munitions officer. AFR 127-100, Explosive Safety, soon to be AFI 91-201, is the "Bible" of explosive safety in the Air Force, with standards prescribed for storage compatibility and quantity/distance criteria for explosive assets.

The Transporter

Munitions officers with responsibilities for nuclear weapons will know more about vehicle requirements and maintenance than most other logisticians, with the exception of transportation officers. There are precise requirements for vehicles that handle or haul nuclear weapons. Even munitions areas without nuclear weapons must be aware of Technical Order (TO) 00-110N-16, Equipment Authorized for Use with Nuclear Weapons, which lists all support equipment, such as vehicles, forklifts, cranes, and specialized equipment. Any deficiency found with an item listed in the TO must be reported through the proper channels, whether the deficiency occurred while in use with nuclear weapons or during normal, day-to-day operations.

Munitions officers can also find their personnel providing support for other agencies and contingencies. For instance, next to the transportation squadron, munitions personnel provide the largest pool of over-the-road truck drivers. During Desert Shield, many munitions organizations found themselves tasked to provide licensed personnel to augment a depleted transportation corps to haul all kinds of supplies across the desert.

The Planner

The fourth traditional discipline within logistics deals with planning and control. While base Logistics Plans (LGX) offices are overall responsible for logistics planning for the wing, base munitions officers have a large responsibility in complying with wing plans. The munitions flight must determine their ability to meet requirements in wing plans. In addition, munitions officers and their personnel should write and execute base-level plans for munitions movements, explosive flight line operations, on-loading and off-loading explosive cargo from aircraft and surface shipments, and special plans involving nuclear munitions.

Other Disciplines

The one area outside logistics that most affects the munitions officer is security. In fact, most munitions officers find themselves

much more familiar with security police personnel than their counterparts in other logistics fields. The relationship between munitions and security should be just as strong as the one munitions officers have with flight line maintenance personnel. Due to the nature of munitions, security plays an extremely large role in daily operations. In most cases, for conventional storage areas, the munitions flight will provide their own security (owner-user). Entry into the area and specific buildings have tight controls and involve a close working relationship with security personnel. Additionally, all munitions plans must have the coordination and approval of security officers.

Other areas of importance to the munitions officer include the safety office, civil engineering, and the base personnel office. Weapons safety officers should practically live with the munitions officer. In many cases, the weapons safety officer serves as a liaison with the rest of the base for the munitions officer. While weapons safety personnel look over the shoulder of munitions planning and operations functions, they also provide a valuable resource for munitions officers to relate the importance of complying with explosive rules and guidelines to the base populace.

Munitions buildings and areas must meet more stringent criteria than most other base facilities. Civil engineers are the experts in this field. This, however, does not relieve the munitions officer from his responsibilities. While the engineers can make the design, it is the munitions officer who must make the design functional for munitions personnel.

Munitions officers with a nuclear mission learn immediately the importance of the Personnel Reliability Program (PRP). The PRP office in the Base Personnel Flight (BPF) provides the technical support to run the program, but the munitions officer deals with the ramifications of the program daily.· In many cases, because of this program, munitions officers will know many more personal details of their troops than they ever wanted to know.

Conclusion

With the drawdown of our forces and consolidation of the logistics career fields, expectations for logistics officers to know more and more about all the disciplines associated with logistics will increase. The munitions flight, perhaps, provides the broadest look at Air Force logistics than most other base-level logistics positions. Base-level leaders should not overlook the wealth of knowledge a young officer can gain working in the munitions area. Officers with the chance to work in munitions should make the most of the opportunity. The knowledge can only help their careers—real-time and in the future. It doesn't take a super hero to do the job, just conscientious munitions officers supported by a solid corps of senior non-commissioned officers.

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Aircraft Depot-Level Reparable (DLR) Cost Per Flying Hour (CPFH) Lessons Learned

Captain Lois Schloz, USAF

One of the newest initiatives on the "maintainer's" plate is tracking the Reparable Support Division (RSD) stock funded items. These Depot-Level Reparable (DLR) items, and how well we track and account for them, are yet another measurement of our management capability. With current austere budget conditions, leadership searches for all possible ways to lower spending while not reducing readiness. Leadership's review of DLR CPFH showed differences in the reported DLR costs between bases with the same Mission, Design, Series (MDS). At the 5 May 1993 Stock Fund General Officers Steering Group (GOSG) meeting, the members tasked us, the Air Force Logistics Management Agency (AFLMA), to conduct a study to determine why these differences exist. The GOSG also wanted us to determine the feasibility of establishing a standard DLR CPFH for each MDS.

AFLMA recently completed the resultant study, entitled "Aircraft Depot Level Reparable (DLR) Cost Per Flying Hour (CPFH) Lessons Learned." The study had three objectives:

(1) Establish reasons for the differences in DLR CPFH.

(2) Collect and publish lessons learned on saving DLR funds.

(3) Determine the feasibility of establishing a standard DLR CPFH by MDS.

We selected the F-15C/D and KC-135R weapon systems for research and chose 6 of 9 F-15C/D bases and 6 of 19 KC-135R bases as study units. We collected two types of data to establish reasons for differences among study units and to create lessons learned. We used FY93 supply transaction data from the study units to determine if differences in CPFH actually existed, and interviewed maintainers and RSD managers to collect lessons learned and determine the feasibility of establishing a standard DLR CPFH.

Results of the study are quite interesting. First of all, MAJCOMs calculated and reported DLR costs differently from one another. This made it bogus to compare units to one another. However, using Supply Transaction Tapes, we were able to confirm a difference in DLR Cost Per Flying Hour between units with the same MDS. The report lists factors causing these differences, many of which are *not within control of unit-level managers.* For instance, *10%* of the applicable stock numbers account for 97% and 79% of total DLR costs for the F-15C/D and KC-135R aircraft, respectively. Of these assets, *over half* are not authorized repair at unit level! While our initial research supports the feasibility of developing a standard DLR CPFH *adjustable for unit-level differences,* it is important for the Air Force to consider the accuracy of such a standard with respect to the cost of achieving that accuracy. In addition to these findings, the report includes lessons learned which we collected during interviews at study units. These lessons include:

- Develop test benches enabling them to test and adjust items close to tolerance limits. Inspect adjacent items for tolerances.
- Submit AFTO Forms 135 (Source, Maintenance, Recoverable Change Request) for assets that units have capability, but not authority, to repair. Chance of approval may be improved by submitting a locally developed procedural checklist with all AFTO Forms 135.
- Establish micro-repair capability using existing personnel, equipment, and Operating and Maintenance (O&M) funds.
- Seek alternate sources for test and repair capability, for example, contractor or another unit. Consider the benefits of obtaining authorized test equipment not already on hand.

- When available, use resources from other units to repair assets.
- Obtain authorization for contract repair through proper channels.
- When possible, consider assigning a full-time RSD manager to monitor and report on the DLR program.
- Place a financial analyst in each maintenance/flying squadron to monitor the RSD funds.
- Assign a supply person in Maintenance Support Flights as another expert to monitor the Due In From Maintenance (DIFM) program.
- When obtaining Special Purpose Recoverables Authorized Maintenance (SPRAM) assets for a newly acquired system, ensure the funds come from the System Program Directorate (SPD), not the RSD fund.
- As an acceptance inspection, have Maintenance Support Squadrons perform functional checks of applicable DLR parts arriving at supply. This identifies parts that are defective before installation on aircraft.
- Aggressively challenge prices that seem high. When successful, process a Reverse Post through supply and reorder at the lower price.
- Many units found the ACC 200 (RSD DIFM Report) the best available product to summarize the transaction history data from the D26 (RSD Transaction Report).

The study also lists eight recommendations:

(1) Establish standardized methods and tools to compute and report DLR CPFH.

(2) Cross feed unit repair rate information to all potential users. Where feasible and authroized, units should use this information to maximize local repair capability, particularly on the top two NSNs driving costs.

(3) Integrated Weapon System Management (IWSM) teams or System Program Directorates (SPD) should investigate high failure components. If deemed appropriate, they should take steps necessary to improve component reliability.

(4) The Air Force should reconsider the need for developing a DLR CPFH standard for each MDS.

(5) Make all lessons learned available to applicable units.

(6) When AFTO Forms 135 are approved, wide-spread, timely publicity is imperative. AFMC should publicize, publish, and distribute approved AFTO Forms 135 quickly.

(7) As there is no adequate automated system to track warranted assets, we suggest phasing in serial number tracking through such technology as MIcro Technology in Logistics Applications (MITLA) or LOGistics Marking and Reading Symbology (LOGMARS). This can be accomplished in conjunction with the current "DLR Ownership Plan" directed by the Air Force Chief of Staff.

(8) The Standard System Center (SSC) should develop management information systems and other tools to help unit-level managers manage their DLR Program. This effort should include inputs from field units as to problems they are experiencing and solutions they recommend.

There are two versions of the final report, a summary version and a full version, complete with specific data and detailed information. To request copies, please contact AFLMA/LGM at DSN 596-4581/4582.

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Most Significant Article Award of 1993

The Editorial Advisory Board has selected "Agile Logistics: The Art of Logistics in the Twenty-First Century" by Keith Shelton and David Davenport, as the most significant article published in the *Air Force Journal of Logistics* during 1993.

Most Significant Article Award

The Editorial Advisory Board has selected "Military Logistics and Business Logistics: Reexaminig the Dichotomy" by Dr Steven Hays Russell, as the most significant article in the Winter 1994 issue of the *Air Force Journal of Logistics.*

Transportation: A Weakening Link of the Logistics Planning Chain?

Major James R. Weeks, Jr., USAF

Ask most any logistician what logistics function in the logistics chain is the most important and chances are you'd get about as many different answers as the number of people asked and each will base their answers on their personal experiences as well as what their specialty is. It appears each has valid arguments for the function they chose as being the most important and it seems therefore much more critical to examine all the logistics functions to determine which is the most neglected. I have chosen the one whose degradation can have the most serious impact on our ability to project "combat power" under the auspices of today's "Global Reach; Global Power" vision. Analysis of past conflicts indicate one factor continues to impact our nation's ability to successfully prosecute a military campaign over significant distance—transportation.

From the Middle Ages to the most recent conflict in the Persian Gulf, historical reviews have shown that an army's mobility and ability to sustain itself (transportation capability) continues to be a serious weakness and a limiting factor.

From the American perspective we have not always had a superior transportation/distribution system. To the military profession, this aspect of logistics has been a significant limiting factor. During the Revolutionary War, our national transportation infrastructure was rather primitive and strategic transportation capability was almost non-existent. Our limited shipping capability was constantly subject to attack by the British and an internal ground transportation system did not exist. Most travel was done by river or over rudimentary dirt roads by private conveyance.

By the Civil War, our ground transportation had expanded with the introduction of the railroad, but the system was inflexible as the location of track limited direction and ultimately commanders' options. They were also very susceptible to interdiction by the enemy creating even more problems for the user. Roadways and river systems had not improved greatly either.

The Spanish-American War demonstrated that although we were an emerging world power we still lacked the ability to effectively and efficiently project our power beyond our shores; in a sense "strategic mobility."

It was not until World War I that we began to recognize the need for increased transportation capability. We began expansion of our maritime fleet to provide logistical support to our overseas allies. We developed an internal transportation system under control of the government, began deregulating the railroads, created the Interstate Commerce Commission, and began to build a highway system as the invention of the automobile was rapidly revolutionizing transportation methods. Following World War I, politically we reverted to a policy of isolationism withdrawing military forces from overseas and discarded the notion of needing to be able to project military power overseas. After all, we had just fought "the war to end all wars."

Defense budgets were cut, and as a result, the nation's military transportation capability suffered. A new capability, however, was looming on the horizon; the use of aircraft to move personnel and material quickly and would eventually replace sealift as the "preferred" mode of transport in years to come. The Douglas DC-3 aircraft would presage a revolution in the concept of global power projection. While initially only capable of what is today referred to as intra-theater airlift, the military version, known as the C-47, laid the foundation for development of bigger and more powerful aircraft such as the C-46, C-119, C-123, and C-124 that were increasingly capable of going farther and hauling more.

Procurement of the military version C-47 was the first step the United States took toward becoming preeminent in rapid global power and projection capability. Leading up to and during the Second World War, the United States built a transportation system second to none in the world. Our airlift and sealift capabilities were unrivaled, and following the war, the lessons learned and infrastructure converted to civilian application greatly aided the overall national economy. Mere physical machines for going farther, faster, and hauling more weren't the only improvements made. President Eisenhower, recognizing the shortcomings of our land transportation capability during World War II and the Korean War, laid the foundation for today's Defense and Interstate Highway System, speeding access to aerial ports and seaports, and also improving internal distribution potential for a growing economy.

From World War II to the Vietnam War the transportation and distribution system of the Department of Defense could be considered the best in the world. It maintained that edge up until the mid-60's when it appears the overall system began to decline—possibly due to technological breakthroughs in propulsion systems, construction techniques, and aircraft design as well as possibly economic consideration at that time. The issue for transportation became more focused on the aircraft and the sealift mode was somewhat forgotten. Logistics support became a speed issue. The "jet" aircraft, initially the Lockheed C-141, gave rise to the concept of what I will refer to as the "speed versus bulk syndrome."

It became in vogue for armed Services to utilize the jet transport to move assets instead of sealift or ground transport. It was perceived that jets would be a more effective method (not necessarily economical) by moving assets to a theater more quickly and directly than sealift.

Consequently, our merchant marine system, which had already deteriorated significantly after 1945 and was the major method of movement of material in both the Korean and Vietnam wars, was relegated to a lower priority and was subsequently ignored by Congress and the Defense Department with respect to funding in favor of the jet transport. From the mid-60's until today, the emphasis continues to be on "airlift." The procurement of the world's largest air transport in the 70's, the C-5; the stretching of the C-141; the purchase of the dual capability KC-10; and lastly, the purchase of the C-17 aircraft all have greatly contributed to improving airlift capability and making us the leader in the world for "rapid" deployment. But even these assets cannot move the "bulk" that is essential today in the time required.

Sealift capability, primarily bulk cargo movement, has decayed to a point of becoming a critical limiting factor. Presidents Carter and Reagan both made some efforts to bolster sealift capability and deal with the "shortfall" in lift with the Near Term Prepositioning Ship (NTPS) program, and the Maritime Prepositioning Ship program that was supported by President Reagan as a refinement of the NTPS. However, the Bush Administration basically hamstrung these programs with only token support in the defense budgets. Presently our nation's ability to support and deploy forces effectively as well as provide sustainment remains in question.

Today the probability for a regional conflict remains high. Our defense strategy supports this concept through the Regional Conflict Management Model. We must possess a flexible and responsive transportation capability to meet the challenge presented by this strategic defense orientation. The Congressional Mobility Requirements Study set goals for the Army of moving a brigade in one month and a light division in two weeks into a theater of operation. I believe we cannot achieve this goal without good sealift and airlift systems that will complement each other. Today the United States Transportation Command (USTRANSCOM) exists to serve as the agent charged with managing the Department of Defense transportation assets. It also possesses major portions of the system in the form of airlift and sealift assets which reside in two of their organizations, the Air Mobility Command and the Military Sealift Command. However, all the resources in the world are useless unless they can be brought to bear in the required locations in a timely manner.

Today we must become a partner in a global community, and as the preeminent air power in the world, be able to project our power quickly to meet any threat. Some see a solution to this dilemma as the C-17, however, purchasing aircraft alone does not solve the transportation problem.

Prior to the Gulf War, the aforementioned Mobility Requirements Study showed that sealift systems (the Merchant Marine) were in critical condition. In 1970 it consisted of 18 major shipping companies totaling over 900 ships. As of today, it has shrunk to 5 companies with less than 365 ships. In addition, airlift systems have begun to show signs of deterioration and are becoming more and more incapable of meeting Defense Department strategic lift requirements. Currently C-141 aircraft are capable of carrying only 80% of their wartime allowable loads as of May 1994 due to aircraft fatigue factors. Full operational capability is expected by December 1994. Material Handling Equipment (MHE) to support air operations is becoming more incapable of meeting needs due to nonavailability of repair parts resulting in increased down time and general age of units making repairs difficult in many cases. One bright spot, however, is the ongoing acquisition program for a 60K loader for aircraft operations to replace the aging 25K and 40K loaders currently in service. Additionally, specialized MHE is desperately needed to support loading/unloading of the Civil Reserve Air Fleet (CRAF) aircraft we know will have to be used in national emergencies, as well as the new KC-10 Extender aircraft we procured to enhance airlift and air refueling capability. Due to height of these aircraft cargo entry doors, most existing systems cannot be used.

Thousands of 463L pallets are needed as well; many as replacements for the countless ones lost or damaged in the Gulf, and a large number as replacement for those that have worn out or been damaged due to daily use or misuse. Nets and straps used with the pallets are also in need of replacement. Upgrading aerial port facilities and capabilities to support over the shore operations of the maritime prepositioned ships are in need of funding also. The list goes on.

Some improvements are being made to capability; purchasing of additional Fast Sealift Ships (FSS), upgrading and conversion of many Ready Reserve Fleet (RRF) vessels, and further development of the Afloat Prepositioning Force (APF). But this still has not been sufficient when the importance of maritime capability is addressed. One disturbing point here is that we haven't even addressed the aspect of what demand will be placed on sealift if in the next conflict we are faced with no friendly host nation that can provide secure ports and unlimited fuel.

Statistics of the Persian Gulf War indicate only 5% of the total dry tonnage was delivered by aircraft. The majority of the items delivered were considered high priority, critical to operations, and not of great bulk. The vast majority of cargo (armor, trucks, artillery, construction material, ammunition, etc.) were moved by sea! A sizable quantity of these items were moved by contract carriers on non-US flagged vessels. Can we afford to allow this situation to occur in future conflicts? The Merchant Marine Act of 1936 stipulates that

> [the U.S. is] . . . required to have a merchant marine that is sufficient to carry its waterborne domestic commerce and a substantial portion of the waterborne export of foreign commerce with the U.S. . . . capable of serving as a naval and military auxiliary in time of war or national emergency.

Why then are we not funding modernization of the present merchant marine or even offering incentives to the private sector to invest in ship building? Bureaucratic red tape and regulations have strangled our shipbuilding industry. From a cost perspective, the government is permitting an unlevel playing field to exist. In other nations, shipbuilding "subsidized" by their government has created a condition in which the US can no longer favorably compete. Basic government regulations, additive requirements placed on shipbuilders by the Coast Guard, the shrinking number of peacetime contracts offered by the Department of Defense, and the "cheap labor" offered in foreign countries to build and operate ships have made operating US-flagged vessels less and less profitable if not almost impossible.

In the case of the Gulf War we experienced no threat of interdiction of our logistics Lines of Communication (LOC), either sea or air. Would it be fair to say that since the systems weren't really "tested," our capability was less than the war demonstrated? Are we being influenced by this false sense of superiority regarding our transportation capability and therefore not devoting the efforts needed to maintain that superiority? Realize also, that in the Gulf War we had an extraordinary time (6 months) to prepare. And while demanding, the pressure on the transportation systems was never really pushed to the limit.

What should be our objective? Today's defense budget shows limited attention being given to improving the transportation system. Airlift is being improved through aircraft purchases, but what is being done to improve sealift, the real workhorse of transportation? What is being done to improve the support functions and training of personnel? Not enough!

Purchasing of additional new Fast Sealift Ships as well as upgrading Ready Reserve Fleet ships to Roll On/Roll Off (RO/RO) capability and converting many to containerized shipment configuration will help, but will this be enough, and done in sufficient time to meet the requirements of the next conflict? What is being done to improve ground transportation capability? All services, especially the Army, were seriously short of heavy equipment transport (HET) and general ground transport vehicles in the Gulf War. Were it not for contracting

of vehicles and availability of these and allied vehicles, we would possibly not have been able to meet timing objectives for the ground war. Most vehicles utilized in the war also had limited off-road ability which impacted mobility in a country with little or no roadway system.

Have we given any effort to protecting the transportation/ distribution system in a hostile environment? Imagine what a "credible" enemy could have done to our system. Looking at the "Highway of Death" between Baghdad and Kuwait City gives one some idea of what could occur. What about the strategic bombing campaign we waged on Iraq and the effect it had on their ability to sustain operations?

My concern is that insufficient emphasis is being placed on upgrading the transportation function of logistics. We are in essence violating several of the principles and tenets of Combat Support Doctrine by failing to address transportation shortcomings. By ignoring the fact that the next war will not be the same as the last, and by not learning from our mistakes, we are dooming ourselves to repeat them. History has shown continual improvement to all systems is necessary to maintain an edge. Can we allow our transportation systems to fall below being the best in the world? A most critical function of the logistics system—transportation—is currently being neglected. Only time will tell what impact this oversight will have on us as a nation.

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(Continued from page 9)

is achieved by gaining experience in operational and industrial logistics—at a variety of levels, both CONUS and overseas. Initially, this should be accomplished in one's primary logistics AFSC. However, subsequent experience in other logistics specialties can only enhance one's abilities as a logistician. Why? The answer is that despite change, the kinds of professional credentials we have come to hold as important still remain important—because they give logisticians the tools they need to be innovative leaders in the current and future logistics environments.

The demographics of professional training and civilian education notwithstanding, however, the core message is this: **The depth and breadth of an individual's experience is still most important.** Second, we can enhance our abilities as military logisticians to better support the Air Force vision—***Air Force people building the world's most respected air and space force - global power and reach for America***—by bringing our military experience, training, and education to bear on our profession of military logistics—making sure they all complement each other. However, we're also discovering through our Lean Logistics efforts that exposure to, and the application of, the civilian educational disciplines and private sector business practices to the military logistics arena is of growing importance. Perhaps it's this area that offers us greatest promise for continuous process improvements in military logistics. With this in mind, let me share some thoughts expressed by General Merrill A. McPeak, the Air Force Chief of Staff, at the first Quality Air Force Symposium held in October 1993 in Montgomery, Alabama:

> . . . we can't relax. We must remain open to new ideas. We have to make the Air Force better. We can't afford to throttle back and level off—we must always have a good rate of climb. My position is that people should come in every morning saying this is a great place to work, but there's still room for improvement. The Secretary and I expect you to continue pushing the limits of excellence. When others look for an example of a quality operation—we want them to think first of the United States Air Force.

We do need to continue to push the limits of excellence, and Lean Logistics is a key means to do so—because it's the system of continuous improvements that brings our logistics structure in line with force structure. We also must reduce our logistics support costs while keeping, if not enhancing, our support capability. **Our challenge: Minimize logistics infrastructure while building and sustaining a ready force.**

As powerful a concept as Lean Logistics is, however, it can't support the level of reductions we'll face in the next few years. As a result, we must further reduce operations and sustainability costs for our weapon systems. Reductions in ownership costs will likely come from reduced demand and consumption from the using commands. User efforts like Fast Fix and Gold Flag are important as they reduce demand through the base-level repair of selected parts, vice disposing of these parts or sending them back to depots for repair. Likewise, reduced costs in the support organizations can reduce direct costs of labor and materials, and can reduce overhead from infrastructure and personnel. Finally, improved programming from the Air Staff can make our internal procedures more responsive, thereby allowing us to better capture savings from MAJCOM initiatives sooner in the budget process.

We can maintain our fighting edge and live within our budgets if we do these things—smartly. The efficiencies realized from Lean Logistics and comparable concepts will help finance our commitment to our people, our technological edge, and our readiness. We must size, structure, and manage our logistics resources carefully if we are to continue fielding the world's most respected air and space forces. Through Lean Logistics, and our individual and collective efforts, we'll turn this vision into a living reality. As we prepare to enter the 21st century, the opportunity to do so is ours for the taking.

Colonel Morrill is currently Commander, 366th Logistics Group, Mountain Home AFB, Idaho.

Air Force Armstrong Laboratory Logistics R&D Program

The logistics Research Division of the Armstrong Laboratory performs research and development (R&D) focused on technology for improving the performance of integrated systems of people, information, and equipment doing essential acquisition and logistics support functions in peacetime and wartime. This includes developing automated job aids and integrated diagnostics for maintenance information trade-off techniques and design tools for integrated product development that allows consideration of weapon system supportability and maintainability from design inception. Applications cover a broad spectrum of field, depot, and space operations with "customers" throughout the Air Force, Department of Defense (DOD), other government agencies, academic institutions, and US industry. The text that follows contains brief descriptions of selected ongoing programs within this Division and is current as of January 1994. Readers interested in obtaining more information about these programs, future plans, or additional details about the Division are encouraged to call the individuals named for each work effort.

AIRCRAFT BATTLE DAMAGE ASSESSMENT AND REPAIR (ABDAR)TECHNOLOGY

OBJECTIVE: Enhance organizational-level ABDAR capability of the USAF by providing battle damage assessors, technicians, and engineers with quick and easy access to assessment and repair information.

APPROACH: A contracted research effort will start in early 1995 and will be accomplished in four major phases. In Phase I, a requirements analysis will be performed to capture user requirements. Phase II will involve designing the ABDAR demonstration system based on the results of the Phase I study. The design will focus on providing ABDAR information to the user through a portable maintenance aid (PMA). The PMA will contain all of the information required by the user such as assessment and repair logic, technical orders, part information, wiring schematics, and troubleshooting data. A graphical user interface will allow the user to easily access and comprehend ABDAR information. The Phase III effort will involve implementing the design software. Finally, Phase IV will involve data authoring, integration, and final testing of the ABDAR demonstration system. Data for a specific aircraft will be electronically created to comply with the DOD Interactive Electronic Technical Manuals (IETM) specifications. Following the contracted effort, an in-house project to obtain user acceptance of the system will be accomplished by performing several field demonstrations with various ABDAR users.

EXPECTED PAYOFFS: Fast and accurate battle damage assessment and repair will lead to improved combat effectiveness by reducing the time to get aircraft back to mission capable status. Less experienced users will have better access to ABDAR information reducing the reliance on highly trained assessors. Deployment capabilities will be enhanced by minimizing the amount of paper technical data and supporting information presently required by the user. (Captain Allen Gwartney, AL/HRGO, DSN 785-3871, (513) 255-6718)

ENHANCED CONTINGENCY LOGISTICS PLANNING AND SUPPORT ENVIRONMENT (ECLiPSE)

OBJECTIVE: To demonstrate new technologies and processes to improve wing-level deployment planning and execution. The overall goal of ECLiPSE is to demonstrate technological and process oriented solutions to deployment planning problems of USAF logisticians.

APPROACH: ECLiPSE will be developed in a two-pronged approach. One prong will rigorously analyze the current wing-level deployment process for shortfalls and weaknesses, and state-of-the-art technologies and process oriented solutions to these problems will be applied and demonstrated. The other prong will demonstrate the technical feasibility of using leading edge software technologies to remedy a weakness found in the deployment planning process during a preliminary ECLiPSE study. Based on this cursory study, the Deployment Information and Simulation Environment (DISE), a sub-set of ECLiPSE, is being developed. DISE will consist of a centrally located knowledge base (KB) that will store deployment site map, site survey, lessons learned, and related war reserve material information; a component to assist planners in collecting deployment site information to populate the KB; and an analysis tool to evaluate all the available information to analyze beddown requirements with respect to beddown site resources. Close coordination with wing-level and MAJCOM logisticians will be vital throughout this program.

EXPECTED PAYOFF: Improved wing-level deployment planning and execution will increase Air Force combat capability. Reducing the mobility footprint will reduce requirements for scarce airlift assets, therefore enabling deployment of additional combat capability. Reducing deployment response time will increase the deterrent effect of our military forces on distant enemies and allow US policy makers to respond more quickly to aggressive actions of distant enemies should deterrence fail. More efficient and effective use of mobility resources will allow the Air Force to maximize its power projection capabilities. (Captain William Z. Zeck, AL/HRGO, DSN 785-2606, (513) 255-3771)

INTEGRATED MAINTENANCE INFORMATION SYSTEM (IMIS)

OBJECTIVE: To improve Air Force maintenance by providing maintenance technicians with an integrated information system capable of providing technicians with all information required to do the job via a portable maintenance aid (PMA). Develop and demonstrate an automated system to integrate and deliver automated maintenance information from various sources to the flight line technician.

APPROACH: This program has three phases. Phase I utilized information modeling techniques (Integration DEFinition (IDEF)) to identify maintenance information requirements. Phase II was the development of the basic system design. Phase III is the system fabrication and field test. State-of-the-art object oriented software technologies are being used for developing the IMIS. The PMA is a special design composed of off-the-shelf modules. This program was worked jointly with the F-16 System Program Office.

EXPECTED PAYOFF: Estimated savings are in the hundreds of millions of dollars for both operational commands and depots organizations. This technology will reduce the number of false removals, reduce the database size, and ultimately reduce the amount of aircraft downtime. (Mr Richard E. Weimer, AL/HRGO, DSN 785-3871, (513) 255-3871)

INTEGRATED TECHNICAL INFORMATION FOR THE AIR LOGISTICS CENTERS (ITI-ALC)

OBJECTIVE: To improve, standardize, and integrate technical and managerial information; and to make it more readily available at the job

to improve the performance of aircraft programmed depot maintenance (PDM) activities.

APPROACH: This effort has two phases. Phase I will involve a detailed requirements analysis of current PDM operations at all Air Force ALCs. This work will build on the work completed in determining flight line requirements, during the IMIS project. Phase II will use the results of the requirements analysis phase to design, develop, and test a demonstration depot-level integrated maintenance information capability for supporting PDM activities.

EXPECTED PAYOFF: Improved efficiency, lower operating costs, and improved technician performance at ALCs. (Ms Barbara L. Masquelier, AL/HRGO, DSN 785- 2606, (513) 255-2606)

INTEGRATED MODEL DEVELOPMENT ENVIRONMENT (IMDE)

OBJECTIVE: To improve the quantity, quality, and timeliness of information based on logistics simulations.

APPROACH: Using commands have ongoing initiatives which are investigating ways of improving their simulation capabilities; however, these programs have taken an incremental approach. This project has taken a much more aggressive approach. State-of-the-art data management, user interface, and modeling methodologies are being incorporated into the IMDE prototype. The goal is to "leap ahead" and demonstrate simulation capabilities far beyond what is currently available. US Army, Navy, and Air Force organizations which utilize simulation in decision support studies, as well as Armstrong Laboratory scientists, will evaluate the utility of the IMDE tool.

EXPECTED PAYOFF: Easier-to-use modeling and simulation software tools that will shorten the time necessary to develop analytic models. (First Lieutenant Todd Carrico, AL/HRGO, DSN 785-2606, (513) 255-2606)

DESIGN EVALUATION FOR PERSONNEL, TRAINING AND HUMAN FACTORS (DEPTH)

OBJECTIVE: To accurately portray work requirements for aircraft and ground support equipment maintenance through computer-graphics simulation. This program will provide Computer Aided Design (CAD)-based tools to allow human performance to be visualized during design evaluation for improved maintainability of new and/or modified systems.

APPROACH: DEPTH is an Advanced Development Program that integrates off-the-shelf human performance analysis with CAD to provide the designer with a high degree of visualization of human performance capabilities and limitations with respect to the product design. The Hughes Missile Systems-developed DEPTH workstation and hosted software combines elements of several leading human modeling and task analysis tools. DEPTH currently includes human anthropometry and strength data contained in the Crew Chief human model developed by Armstrong Laboratory. Articulation, animation, and behavior of the human figures are implemented through the Jack system developed by the University of Pennsylvania. Linkage of basic human motions into subtasks and analysis of complete maintenance actions is provided by the networking capability of the Human Operator Simulator (HOS-V) developed by Micro Analysis and Design, Inc.

EXPECTED PAYOFF: Cost avoidance in human resources through better job design using DEPTH has been estimated to save about $1.2 million annually for a deployed wing of F-15s and F-16s. (Captain Edward C. Rooks, AL/HRGA, DSN 785-9945, (513) 255-9945)

GROUP RESEARCH LABORATORY FOR LOGISTICS (GRLL)

OBJECTIVE: To refine and develop computer aids that can help groups of collaborative workers reach their goals more effectively and efficiently. Of particular interest is supporting groups of individuals who must collaborate across the boundaries of time and place.

APPROACH: The GRLL is an in-house, state-of-the-art electronic meeting room (e.g., a room with sophisticated electronic tools to support problem solving groups). The GRLL is equipped with 15 workstations, a control console and a large, color, front-screen projection system. Researchers provide facilitation and software tools to help the group work together toward the group's goals. Some of the tools help the group generate ideas, organize their thoughts, and evaluate potential solutions. Problem-solving groups that use the GRLL assist the researchers by evaluating the success of these electronic tools and providing insight into group problem solving activities. These groups have provided incentive for exciting new research in extending support for groups who cannot meet at the same place and time. **AL/HRGA actively seeks problem-solving groups within the Wright-Patterson community that are willing to explore this exciting new area.**

EXPECTED PAYOFF: During the first year of use, the GRLL has demonstrated its ability to support many types of goal-oriented Air Force groups, meeting in a same time, same place environment. Additional research in this area will result in expanding the boundaries of the traditional (same time, same place) meeting to allow group members to participate in a new type of "meeting" that takes place across the boundaries of time and place. (Captain Kennon J. Moen, AL/HRGA, DSN 785-8363, (513) 255-8363)

INFORMATION INTEGRATION FOR CONCURRENT ENGINEERING (IICE)

OBJECTIVE: To develop technologies critical to effectively manage information resources in support of Concurrent Engineering.

APPROACH: The IICE program is using both experimental and theoretical research to explore the challenge of defining information-integrated systems and to more effectively perform functional process improvement. The program is divided into eight thrust areas (Experimental Tools; Methods; Technology Transfer; Integrated Systems Theory; Three-schema Architecture; Frameworks; Ontology; and Applications) to research ways to better share and manage information. A demonstration of IICE technologies is underway at the Oklahoma City Air Logistics Center to streamline the E3 Programmed Depot Maintenance operations, processes, and data flows.

EXPECTED PAYOFF: Taken together, the thrusts of the IICE program are providing the tools and engineering foundations for creating integrated systems and improved AF processes. The resulting products will provide strategic planners with reliable roadmaps for change, and users with systems that serve their needs. (Captain JoAnn M. Sartor, AL/HRGA, DSN 785-7775, (513) 255-7775)

OPERABILITY ASSESSMENT SYSTEM (OASYS)

OBJECTIVE: To develop and demonstrate a simultaneous engineering methodology which provides operational users and designers with a common paradigm for identifying, evaluating, and reducing operability issues throughout the life cycle of complex weapon systems. Provide tools and techniques for users and engineers to: (1) identify high operator/crew task demands, (2) optimize human/system performance, (3) evaluate crew size/composition, and (4) conduct man/machine functional allocation trade-offs.

APPROACH: This advanced development program is a toolbox analysts can employ to investigate operability issues. The toolbox contains requirements definition tools, rapid prototyping tools, system emulation tools, human-in-the-loop evaluation tools, behavioral models, and data collection and analysis tools. All tools are designed to be usable by noncomputer scientists. The tools are integrated through a modular software framework that allows an analyst to "plug in"

needed modules. A unique aspect of OASYS is that when evaluating a multi-crew environment, OASYS can provide artificially intelligent human operator models capable of operating the individual crew stations, as well as accommodate real human-in-the-loop operators. The human operator models would serve as additional crew members during human-in-the-loop analysis of the design.

EXPECTED PAYOFF: OASYS supports designers in determining the right mix of automation and allocation of function and crew sizing, while reducing usability problems. The benefits of such analytic capabilities include more effective and efficient system designs, fewer retrofits to correct design deficiencies, and increased user acceptance of new and/or modified systems. (Mr Jeffrey L. Wampler, AL/HRGA, DSN 785-1612, (513) 255-1612)

REQUIREMENTS ANALYSIS PROCESS IN DESIGN FOR WEAPONS SYSTEMS (RAPID)

OBJECTIVE: To enable more efficient and accurate definition, analysis, and management of weapon system requirements as an integral part of the systems engineering model of acquisition.

APPROACH: The RAPID project approach includes 10 months of data gathering and evaluation; 15 months of design, implementation and initial demonstration; and 13 months of researching extensions such as expert system technology and integration with other analytical tools used by development and mission planners. Phase I was a period of model building, determining RAPID user needs, and conceptualizing RAPID use. Initial software design efforts included evaluating off-the-shelf software, selecting a basic hardware/software platform and operating system, and arranging field demonstrations. Phase II is oriented to coding, testing, and user validation of both the concept and the software. During Phase III users will conduct a demonstration and participate in the definition of extensions to the basic requirements management software. Expected extensions include refining the knowledge base foundation, and making the software concurrently available to geographically separated action officers.

EXPECTED PAYOFF: RAPID offers the potential of reducing manpower efforts through the standardization and reuse of critical acquisition data. This software application offers operational users, designers, and the acquisition corps iterative and effective use of requirements data throughout the system life cycle. (Ms Janet L. Peasant, AL/HRGA, DSN 785-8502, (513) 255-8502)

SUPPORT EQUIPMENT EVALUATION/ IMPROVEMENT TECHNIQUES (SEE/IT)

OBJECTIVE: To analyze problems and determine potential solutions and technology shortfalls pertaining to aircraft support equipment (SE) in general and aerospace ground equipment (AGE) in particular.

APPROACH: This exploratory research and development effort will contain four data gathering and analysis tasks. The first task will include expanding the information and capabilities of an existing Logistics Research Division database focused on AGE. This expansion will allow the user to determine aircraft support requirements (for example, electrical power) for any cross section of aircraft associated with a composite wing. In addition, it will provide various other information associated with AGE (for example, reliability and maintainability metrics) that will be required for the third and fourth tasks. The second task will require gathering data on existing AGE technology as well as current and near-term technologies for weapon systems that could be modified or directly implemented in existing or future AGE. This data will be placed in an electronic format in a manner that will allow for easy access by personnel associated with AGE procurements. The third task will include analyzing the data gathered in the first two tasks to determine shortfalls in existing AGE as well as existing and near-term technologies that could significantly impact AGE usability, reliability, maintainability, supportability, and deployability (URMS&D). A secondary result of this task will include a set of potential AGE modifications and technology insertions to improve the URMS&D of AGE. The fourth task will be a series of simulations and analyses performed to determine the best mix of AGE modifications and technology insertions to affordably improve AGE URMS&D.

EXPECTED PAYOFF: This effort will result in two previously unavailable data sources to aid in future AGE procurements. If properly used, these data sources should allow future AGE procurements to incorporate previously ignored technologies while improving the URMS&D of AGE. In addition, the simulations and analyses will result in one or more recommended Air Force actions including AGE modifications, AGE procurements, and laboratory research programs with documented cost/benefit analyses for each action. (Mr Matthew C. Tracy, AL/HRGA, DSN 785-8502, (513) 255-8360)

COMPUTER AIDED BUSINESS ENGINEERING (CABE)

OBJECTIVE: To develop and demonstrate technology that allows Air Force acquisition and logistics agencies to more effectively support business process reengineering (BPR), technology readiness evaluations, organizational changes, and the implicit and explicit human issues relevant in implementing these technologies.

APPROACH: Through a combined in-house and contracted effort, this advanced development research program will develop and demonstrate a toolbox and methodology to assist AF managers in performing BPR. Various BPR tools to be developed or obtained to support this effort include planning, process description and modeling, simulation, process control and management, workflow, decision aid, prototyping, and performance measurement. The AF is undergoing tremendous change due to changes in military threat and decreased budget allocations. AF managers are unable to make needed process and organizational changes fast enough due to a lack of a BPR methodology and tools suited to their needs. Most current BPR methodologies and tools are focused on achieving radical improvements in the commercial sector and often fail when applied to government processes.

EXPECTED PAYOFF: CABE will provide AF users with the methodology and tools needed to perform BPR and to implement technology to support the reengineered processes. By radically redesigning their business processes through BPR, AF users will achieve dramatic improvements in critical performance measures such as cost, quality, service, and speed. The long-term goal will be an increased war fighting capability with less supporting resources and manpower (that is, improve tooth to tail ratio). (Captain Robert V. Goerke, AL/HRGA, DSN 785-7774, (513) 255-7774)

A Logistics Life Cycle Cost Guide for the Program Manager

Colonel Martin D. Carpenter, USAFR

Introduction

It is the intent of this paper to provide any program manager with a guide to estimating logistics life cycle cost (LLCC) for a system. The thoughts and opinions in this paper are based upon my experiences as a government employee working on the acquisition of electronic systems for the Naval Air Systems Command, and as a private sector employee of Allison Engine Company providing aircraft engines to the military. While the focus of this paper will be on military acquisition programs, the matrix aspect of the guide can be modified and used for other types of government or commercial programs. Since government program managers generally receive a significantly greater amount of training in the life cycle cost arena than do those in private industry, the target audience for this paper is primarily the private industry program manager and his or her staff. This guide will not have significant detail, but will focus on the elements that make up LLCC, what should be considered when defining these elements, and *one* method in which they can be packaged to provide program logistics costs. Hopefully, it will become another tool in the program manager's tool kit to help properly define the scope of a program, ensure that the program stays within budget, and that is completed on time.

Logistics life cycle cost is the measurement of the price of an integrated logistics support (ILS) program. The importance of accurately identifying that cost becomes apparent when the objectives of integrated logistics support are addressed. These ILS objectives are:

(1) To develop support requirements that are related consistently to design, readiness objectives, and to each other.

(2) To effectively integrate support considerations into both the system and the equipment design.

(3) To identify the most cost-effective approach to supporting the system when it becomes operational.

(4) To ensure that the required support structure elements are developed and acquired. (2:174)

In a perfect world, once a system was designed, produced, and fielded, there would be no "care and feeding" required. It would:

- Require no fuel to operate.
- Never fail; therefore no spare parts or maintenance personnel would be needed.
- Not require training programs, technical publications, support equipment, support personnel, packaging, handling, storage and transportation or facilities, etc.

In short, once a system was fielded, it could basically be forgotten about. While no program manager in the acquisition business actually forgets about integrated logistics support, many do, regrettably, *wish* they could forget about it and deal with ILS accordingly.

In some military system acquisition programs, logistics takes second place to the engineering and development efforts. The program manager, whether it be the government's or the contractor's, is primarily concerned with achieving a functional system design, building prototypes, and ensuring a successful completion of test and evaluation. Some degree of integrated logistics support is always contracted for, but there are times when the government and/or the contractor may not direct the money or the manpower to adequately complete the effort. This usually occurs when significant technical problems arise or when total program resources are limited and short-term tradeoffs have to be made. Their attention may not refocus on logistics and support of the production system until about the time the system enters operation in the field. Only then do they begin to realize the price of the tradeoffs that they have made. By then it may be too late to undo decisions that might have been made differently had additional information been available earlier.

This paper contains three major sections:

(1) A discussion of the importance of a logistics life cycle cost matrix from the perspective of both the government and contractor program manager, as well as that of the customer—the government.

(2) A look at the various uses for an LLCC matrix.

(3) The development and description of an LLCC matrix and a demonstration of its use.

Importance of an LLCC Matrix

The Customer's (Government) Perspective

When the government decides to acquire a system for the military, its goals are no different than that of a commercial customer acquiring a nonmilitary system. It wants a system that will adequately accomplish the task for which it is being procured, be priced as realistically as possible, and have minimum logistics costs. The elements of an adequate logistics program, and the associated costs, must be addressed and controlled early to keep total program costs down. While the vast majority of the expenditures on a program occur after Milestone II (Review of Demonstration and Validation phase and decision point to initiate Full Scale Development phase), the bulk of the life cycle costs *committed*, and therefore difficult to change, occur *before* Milestone II. (1:3-C-4)

A simple but comprehensive logistics life cycle cost matrix, defined properly and calculated with currently available spreadsheet software, can provide the government with cost figures that can assist it with:

(1) Pre-contract award analysis capability.

(2) The establishment of comprehensive criteria for source selection.

(3) Cost-benefit analysis/trade study evaluations.

(4) Post-contractor award performance review capability.

From my experience however, logistics objectives for a system, developed through the LSA process, currently have little influence on the above mentioned uses. The result is that many times the final logistics requirements will exceed the budgeted

financial and manpower resources allocated to meet those requirements because earlier requirements were not factored into the decision-making process. It is in the best interest of the government (customer) to properly identify logistics requirements and their associated costs early. A workable logistics life cycle cost matrix, using realistic input data in providing an unbiased output, can save the government money, save the program manager headaches, and provide the end user a better product with which to operate.

Government Program Manager Perspective

The three basic parameters of acquisition that the program manager must concern himself or herself with are cost, schedule, and performance. A change in one will almost always mean a change in one or both of the other parameters. For the government program manager, cost and the technical portion of performance are generally the two main drivers with emphasis varying between the two from program to program. Once a contract has been awarded, the program manager has specific cost and total (technical and support) performance requirements that he or she must balance. An LLCC matrix can help the program manager in the decision making process as he or she begins to face the inevitable tradeoffs that occur between the two.

The matrix can provide the program manager with cost data for various maintenance options, spare parts inventory requirements, energy consumption estimates, support equipment requirements, etc. It allows the program manager a relatively easy way to compare various ILS options and their long term financial impact on the program. An optimum ILS package, that balances the level of support with long-term cost, can be estimated and then monitored as the program progresses.

Another valuable use for the LLCC matrix is to analyze the impact of various design options for a system and the impact of each on the logistics support required to keep it operating. Recently there has been a great deal of emphasis on up-front logistics support analysis and the positive influence it can have upon system design. MIL-STD-1388-1A prescribes five major LSA task categories that must be accomplished when a program is initiated. They are:

(1) Program, Planning, and Control.
(2) Mission and Support Systems Definition.
(3) Preparation and Evaluation of Alternatives.
(4) Determination of Logistics Support Resource Requirements.
(5) Supportability Assessment. (1:4-R-2)

The data resulting from the performance of the logistics support analysis records (LSAR) tasks is then documented in the LSAR per MIL-STD-1388-2A or in Relational Data Tables per MIL-STD-1388-2B. This results in output summaries or other logistics products that the program manager can use in his decision making process. (1:4-R-1) While adherence to the MIL-STD-1388 documents is now a contract requirement on most programs, its actual influence upon system design is still minimal at best. Part of the reason for this is the inherent reluctance of engineers to change their design for other than technical performance-related issues. However, the real reason probably lies in the fact that the program manager has no verifiable means to demonstrate the long-term logistics impact of different design options. An LLCC matrix can take the support requirements for each option and approximate the financial impact over the operational life of the system, thus giving the program manager the information he needs to make programmatic tradeoffs.

Contractor Program Manager Perspective

The situation for the contractor program manager is much the same as it is for the government program manager when it comes to the cost, schedule, and performance of a program. However, the contractor has one additional element under the cost parameter that the government program manager does not have—profit margin. Cost overruns on firm-fixed-price contracts are eaten by the contractor unless he can show that the government directed the scope or schedule changes that have forced the increase in cost. Utilizing oversimplified options, if a company is overrunning a firm-fixed-price program, and therefore not making a profit, it may (1) go out of business, leaving the government with no program; (2) force the government to cancel the program (US Navy A-12 Avenger) once again leaving the government without a program; (3) force the government to "eat" the cost overruns; or (4) stay in business but avoid government programs in the future. Now that the government is getting away from firm-fixed-price developmental contracts, and going back to cost-plus contracts, the risk for the contractor is reduced while the risk for the government is increased. The importance of accurate life cycle cost estimates up front in a program is very apparent. Otherwise it can become a very costly situation for the government.

It has been my experience that contractor program managers do a poor job of telling their management, as well as the government program manager, the realities of logistics life cycle costs for any or all of three reasons. First there is a strong tendency to "shoot the messenger" when either corporate or government management hears news they don't like, true or not. Second, management may ignore the news, even if they do believe it, because the resources are not available to accomplish the tasks. And third, even if management is open to real-world data, the current tools being used to project LLCC lack credibility. While an LLCC matrix cannot prevent the first or second reason for communication failure, it can improve the reception LLCC data receives by providing a credible means of projecting costs. AN LLCC matrix can be a valuable tool for the program manager to enable him or her to better stay within cost estimates, and hopefully, to maintain a reasonable profit for the company.

Uses for an LLCC Matrix

Pre-Contract Award Analysis

A potentially valuable use for a logistics life cycle cost matrix is during the pre-contract award analysis of a conceptual system. When Phase 0 (Concept) of an acquisition program is complete, an LLCC matrix could provide a comparison of logistics costs for various designs as well as an overall LLCC "should cost" figure to better justify funding for program initiation. In comparing several design options, various maintainability and supportability issues could be examined on paper. Their impact upon system performance and acquisition costs could then be addressed by the engineering and the financial departments. Comparison of conceptual design options on logistics life cycle costs could help identify the optimum design, from a total life cycle cost perspective for the stated requirements, and assist in developing the final specification. Additional time and money spent on a better front end analysis will most likely save a considerable amount of money over the operational life of the system.

Once an optimum design specification has been agreed upon within the government, an overall LLCC "should cost" figure

can be determined to assist in justifying program costs to higher-level reviewers and decision makers. The same in-depth analysis that helped select the optimum design also provides a considerable audit trail to justify acquisition funding. Government acquisition programs undergo great scrutiny and require large quantities of justifying documentation. Also, if realistic data is used in the matrix by both the government and the contractor, cost overruns could be minimized since credible numbers would be used up front. As with any formula, model, or matrix, the accuracy of the answer is a function of the data used to arrive at the answer.

Criteria for Source Selection

Having been involved in the source selection process as a government employee, I have found the process to be a somewhat subjective one with only a moderate amount of objective criteria below the surface of the particulars of the specification. Generally, if the contractor says he will meet or exceed the specification, and is the low bidder, he gets the contract. As history has shown, this is not a very good indicator of success. In any environment, but certainly in today's austere fiscal environment, a much better analysis of a design in Phase 0 can save the government money. The additional benefit of a better analysis is that specific criteria can be developed to ensure that bidders understand the factors that are involved in meeting the proposed contract requirements.

A logistics life cycle cost matrix provides more than just a total cost figure. Each logistics element provides a guide as to what items should be considered when an integrated logistics support program is being put together. The more scrutiny each logistics element receives in the early stages of a program, the less likely something will be overlooked that could impact the program later. The Phase 0 analysis of logistics elements and sub-elements provides criteria to ensure that the bidder(s) understand what is involved in meeting the contract requirements. This will hopefully prevent a contractor from winning a bid without a firm grasp of what is required to successfully develop logistics support.

Post-Contractor Award Analysis

We've looked at how an LLCC matrix can help identify optimum system designs, establish logistics "should cost" figures for funding, and develop logistics support criteria for source selection. Once the contract has been awarded, the detail and value of the matrix begin to grow. In a perfect world, nothing would change in a program from the time a contract was awarded until the system becomes operational. Since we live in a dynamic, ever-changing world, program requirements change, technology advances, and Murphy's Law takes its toll. An LLCC matrix can assist in evaluating change and its impact upon logistics support. It can be used to conduct cost-benefit analysis/trade studies and provide program logistics life cycle cost updates.

Through my involvement in military acquisition programs, I have discovered that cost-benefit analysis/trade studies usually take only an optimistic, superficial look at the impact of a system change upon integrated logistics support. While few people will acknowledge it, cost-benefit analysis/trade studies are generally conducted to justify predetermined positions, usually for political reasons. Used properly, an LLCC matrix will force a pragmatic review of each logistics element to see whether it is affected, and if so, how much. While the answer may not be to the program manager's liking, it will at least identify those issues that have to be addressed eventually if that course of action is continued.

Once a system change has been approved, the LLCC matrix allows the total logistics cost figure to be updated. Again, this new figure, with supporting data, can be used to justify additional funding if required. As the program changes, the matrix is updated to reflect the change and its impact upon the logistics life cycle cost. The program manager should have an accurate picture, at all times, of his ILS program based upon the current system design being pursued.

An LLCC Matrix

Description

Figure 1 shows how logistics life cycle cost fits into the total life cycle cost (LCC) picture. (3:3) There are three general categories of expenses when computing the LCC of an acquisition program:

(1) The Research, Development, Testing, and Evaluation (RDT&E) category which includes everything up to the Milestone III (Review of Full Scale Development and decision point to initiate Production phase) decision.

(2) The actual acquisition stage (Phase III) when the system goes into production and enters the field.

(3) The LLCC category (Phase IV) which includes the expenses to support the fielded system.

There are of course some overlaps in these categories. For example, initial spares are usually bought with production money, not operating and support money. However, from an accounting standpoint, they should be counted as a logistics cost, not a production expense. Also, logistics support analysis occurs during all phases of the program but is most accurately categorized as an LLCC expense.

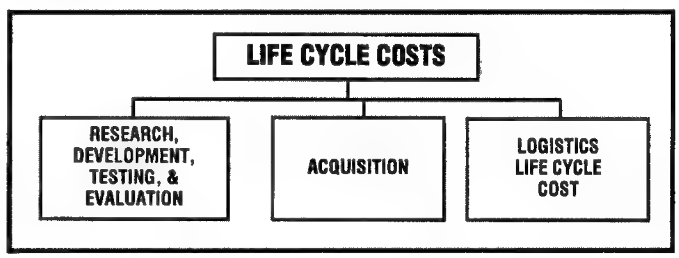

Figure 1. Life Cycle Cost (LCC) Major Categories.

Figure 2 gives a more detailed picture of the logistics elements that make up LLCC and how they support the total LCC program. (3:3) As can be seen, there is certainly more to supporting a system acquisition program than first meets the eye. Because many of these elements are taken for granted, logistics issues and their related expenses are often overlooked. Software models or spreadsheets do exist, or can be easily developed, to project life cycle costs for each logistics element. Each element however, must be acknowledged at the beginning of the program and defined properly for that program to be of any real value. From my experience, this has been, and will continue to be, somewhat difficult to accomplish since funding is usually limited and contractor program managers are inherently reluctant to spend money on logistics issues until the system is ready to become operational. The matrix that this paper describes has five categories of logistics life cycle cost. They are:

- Logistics Support Analysis.
- Initial Support.
- Operating and Support.

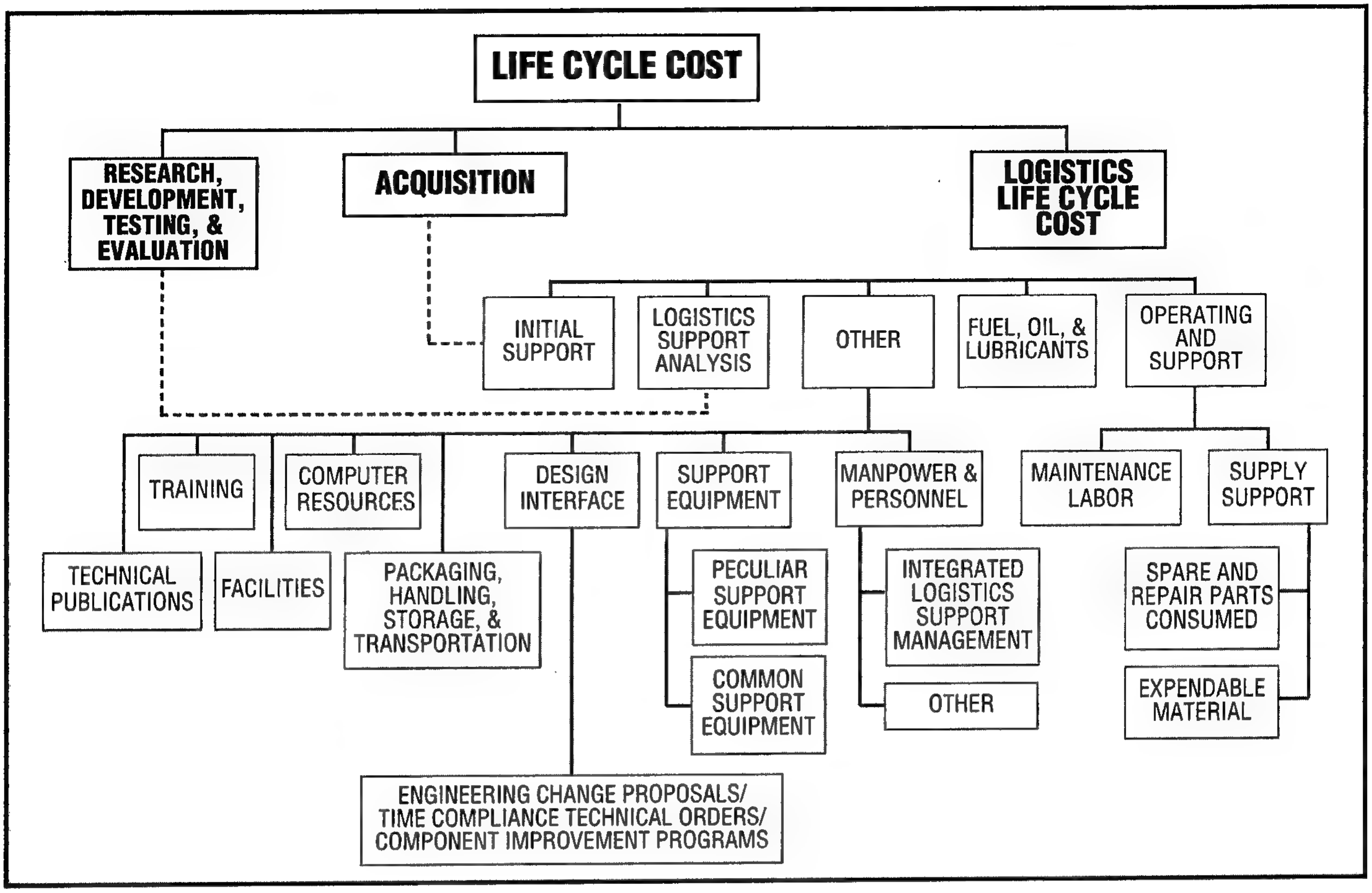

Figure 2. Logistics Life Cycle Cost (LLCC) Elements and LCC Integration.

- Fuel, Oil, and Lubricants.
- Other.

Three of these categories, "Logistics Support Analysis," "Initial Support," and "Fuel, Oil, and Lubricants" will be described under Logistics Element Definition. The two remaining categories, "Operating and Support" and "Other," will be explained below from the context in which they are used in this paper. Their sub-elements will also be discussed under Logistics Element Definition.

Operating and support costs (O&S) are maintenance labor and the consumed supply support elements of non-initial spare and repair parts and expendable material. Initial spare and repair parts and fuel, oil, and lubricants are placed in separate categories, not O&S, to better isolate and identify their costs. This has benefits when comparing systems during source selection and when examining design changes after production has begun.

The "Other" category combines the remaining logistics elements that are most generally associated with integrated logistics support. They are:

- Technical Publications.
- Training.
- Facilities.
- Computer Resources.
- Packaging, Handling, Storage, and Transportation.
- Design Interface.
- Support Equipment.
- Manpower and Personnel.

Logistics Element Definition

The below listed major logistics elements, defined in general terms, make up the logistics life cycle cost portion of an acquisition program. Each element must be examined when computing the LLCC of a program. In the first phase of the program, LLCC projections are little more than educated estimates. With each new phase, more detail becomes available and increasingly accurate calculations are possible. The key to consistent estimates, at all stages of the program, is a realistic appraisal of each logistics element based upon its historical impact upon previous programs and its potential impact upon the current program. Required manpower and travel expenses must always be factored into the cost of a logistics element.

Logistics Support Analysis (LSA). Logistics support analysis is a detailed, comprehensive look at the logistics support resources necessary to support a system and its related support equipment. Its purpose is to identify design characteristics that will provide the customer with the best design while reducing the logistics life cycle cost of the system. (5:3-1) Ideally, the LSA process should begin during the pre-Milestone 0 (Concept Exploration) activities and be staffed quickly and adequately to influence system definition during Phase 0 (Concept) and Phase I (Demonstration and Validation) of the system acquisition. Most of the costs for this effort will be funded during the RDT&E stage of the program.

After Milestone II, LSA should provide system analysis as required and updates to the logistics support analysis record (LSAR) throughout the life of the system. (4: Chart) **A properly conducted logistics support analysis is the key to reducing**

logistics life cycle costs. The LSA process significantly affects all of the other logistics elements. The program manager who recognizes this fact, funds the effort properly, and ensures that adequate numbers of qualified personnel are assigned to the effort, will be well on the way to a successful program.

Initial Support. Initial support is that logistics support purchased by the customer with acquisition funding. (3:3) The major contributors to this element normally include the initial spares and the logistics support portion of the Production Engineering Support (PES). Initial support is funded out of production money and not support money, but is considered part of logistics life cycle cost. Therefore, it is shown as a dotted line to acquisition and a solid line to LLCC in Figure 2. Computing initial support costs separately allows the forecasting of appropriate budgetary estimates.

Technical Publications. The purpose of this element is to produce technical publications that enable the customer to operate and maintain a system at the peak of its capability with minimum logistics life cycle cost. (5:8-1) The publications will be based upon the approved LSA database with enhancements as necessary. Technical publications support involves contractor and government (acquisition and end user) personnel in the development of technical data, the production of publications, and the coordination of periodic reviews to determine requirements for revision.

Training. This element defines the requirements for personnel, training, and training equipment for the system. (5:7-1) It includes contractor and government personnel requirements in the development and production of training documentation and equipment, the establishment of a contractor- or customer-operated training program, the training of trainers, and the periodic update of training materials. The training program will be based upon the logistics support analysis of the system and the technical publications produced to support the system.

Facilities. The facilities element describes the approach for defining, developing and implementing a facilities program to support the production system. Those site requirements and functions are generally identified as operational facilities, maintenance training, depot, and mobile maintenance facilities. All maintenance facility planning for the identified site requirements will be based upon, and traceable to, data provided in *the logistics support analysis. (5:11-1)*

Packaging, Handling, Storage, and Transportation (PHS&T). Packaging, handling, storage, and transportation requirements have a greater impact upon the operational aspects of a program than the costs would imply. All requirements must be identified and accounted for early in the program. Integration of the PHS&T element with the LSA/LSAR is of primary importance in carrying this out. The LSAR must be used as the basis for all associated data elements to ensure that the information contained in PHS&T-related records is at all times consistent with the balance of the LSAR. (5:12-1) A component's reliability can be greatly influenced by the manner in which it is packaged, the type of handling equipment and procedures that are used, where and how it is stored, and the mode of transportation used to move it from one location to another. (1 :3-R-5)

Computer Resources. The purpose of this element is to identify the facilities, hardware, software, documentation, manpower, and personnel required to operate and support mission critical computer hardware/software systems. The difficult part of dealing with this element is finding a funding "home" for these resources because it crosses the lines of responsibility into other ILS elements. It is important that this element be coordinated by a single computer resources manager. (1 :3-R-4) A thorough review, acknowledgment, and funding of computer resource requirements by the program manager up front can prevent the cost overrun drills generated by unbudgeted computer resource acquisition.

Support Equipment. This element encompasses the costs associated with the selection, design, procurement, and support of support equipment. The objectives of this effort are (1) to maximize the utilization of common support equipment and (2) to minimize the requirement for peculiar support equipment. This must be accomplished by enhancing the operability/supportability/durability of the system while minimizing the support personnel and skill level requirement. The logistics support analysis process and the logistics support analysis record are important factors that must be taken into consideration when identifying support equipment needs. (5:9-1)

Manpower and Personnel. The manpower and personnel element covers personnel not included when determining requirements and computing costs for the other logistics elements. It generally includes integrated logistics support management, administrative, and "other" people not easily placed in other elements. Maintenance labor requirements could easily be identified under the manpower and personnel element but, for the purposes of this paper, are categorized as a logistics life cycle cost under operations and support.

Supply Support. Supply support consists of the spare and repair parts and expendable material used to support a system's maintenance effort. Integration with the LSA process and the LSAR is of primary importance when computing supply support requirements and costs. The LSAR is used as the basis for all associated data elements to ensure the information contained in the appropriate data records is, at all times, consistent with the balance of the LSAR. Accurate reliability projections are certainly an important aspect when determining spare and repair part requirements. Unjustified optimism, with respect to the reliability of a system and its components, can leave a program short in spare and repair parts and funding in the supply support arena. (5:10-1)

Design Interface. Design interface involves the relationship and impact of logistics-related design parameters to readiness and support resource requirements. (1:3-R-5) Logistics life cycle design interface costs also involve the logistics support of Engineering Change Proposals (ECPs), Time Compliance Technical Orders (TCTOs), Component Improvement Programs (CIPs), etc. It must be remembered that any of the design interface efforts will impact many, if not all, of the logistics elements listed under the "Other" category in Figure 2. Support requirements for these efforts may last throughout the life of the system and must be identified early and accurately to ensure that adequate funding is made available.

Fuel, Oil, and Lubricants (FOL). Fuel, oil, and lubricants have historically made up a large portion of the logistics life cycle cost of any system when petroleum was the primary source of energy. Now that alternative sources of energy are available like natural gas, nuclear, or solar, this may or may not be true. Additionally, if electricity is the primary fuel used by the system, another question arises. Is it purchased from an independent source (electric utility) or produced from one of the above mentioned energy sources as part of a self-contained energy program? FOL considerations such as source, availability, dependability, and cost are significant LLCC drivers that cannot be ignored.

Program Comparisons Using an LLCC Matrix

A logistics life cycle cost matrix can have value at any stage of a program as discussed earlier. From the customer program

manager's perspective, however, a matrix can have a significant impact upon a program during the source selection phase of a competitive program. Accurate LLCC projections can, and should, influence the selection of a production system if the logistics cost of one system is identified as reducing the overall life cycle cost of that system when compared to another. It is, of course, during the source selection phase that the data used in long-range forecasting is the least accurate. Depending upon the accuracy and detail of the software models used for each logistics element, the assumptions used in defining the boundaries of the element, and whether a realistic vice optimistic view of the element requirements is taken, the LLCC matrix can provide a very good or a very poor forecast.

One way to demonstrate the importance of the logistics life cycle cost matrix is to look at two programs involved in a source selection process (see Figures 3 and 4). The numbers for Program A were taken from an actual aircraft engine program while the numbers for Program B were generated to demonstrate how the LLCC matrix can be used. The programs will be compared with respect to the impact of logistics life cycle cost on the life cycle cost of each program over a 20-year period. The programs will be major aircraft engine programs involved in a competition for a new aircraft. The following assumptions will be used when comparing the two programs:

(1) Both programs received the same amount of RDT&E funding through Milestone II.

(2) Both programs meet the minimum requirements of the specification.

(3) The Program B engine attained reliability, maintainability, and supportability (RM&S) figures 30% better than Program A.

(4) The Program B engine has a specific fuel consumption (SFC) 10% less than the Program A engine.

(5) The winning engine will be determined at Milestone II.

Each program will be discussed below with the emphasis being upon the differences between Program A and Program B. The life cycle cost matrix covers only 20 years for the sake of simplicity. A real engine program would probably last longer with the end of service date not defined.

As can be seen from the matrix in Figure 3, the percent make up of the major categories in the LCC matrix for Program A is RDT&E, 2.56%; Acquisition, 23.94%; and Logistics Life Cycle Cost, 73.5%. (3:10) When seen from this perspective, it is obvious to the program manager how important it is to minimize the logistics cost of a program. Almost three quarters of the total program cost is support related, with fuel being over half the program cost. These percentages are representative of a major aircraft engine program. Other systems, big or small, will have unique percentage profiles based upon the system type. It should be remembered that the logistics elements will almost always be the same, regardless of system type.

The matrix in Figure 4 shows the life cycle cost figures for Program B. The percent of total figures for Program B are RDT&E, 2.80%; Acquisition, 27.98%; and Logistics Life Cycle Cost, 69.22%. The first major life cycle cost category in Program B, RDT&E, shows a larger percent of total cost even though the absolute cost is the same as Program A. This is, of course, because the acquisition and logistics life cycle cost percentages have changed. For the purposes of this analysis, it has no affect on either of the other two major categories and will be ignored.

When the program manager begins to compare the acquisition costs of the two programs, Program B has absolute costs of about $67 million more and a percent of total of about 4% more, than Program A over the entire acquisition cycle. Company B has designed a higher quality engine with improved reliability, maintainability, and supportability features, but which costs more to manufacture. If the program manager stops his analysis here, and ignores the logistics life cycle cost category, he will, most likely, choose Program A because of the short term political and fiscal pressures from his service, DOD, Congress, or the Administration. Regrettably, the near term bottom line may take precedent since acquisition must be addressed immediately while long term support can be dealt with on somebody else's "watch."

If the program manager looks further, he or she now sees some good news. When looking at the logistics life cycle cost of Program B, the program manager sees that the percent of total is more than 4% less than Program A. In the review of the LLCC category, the program manager now notices that Company B has spent more up-front money on logistics support analysis. Company B has chosen to spend additional money on LSA in order to translate its design, reliability, maintainability, and supportablity advantages into reduced logistics costs. As was stated earlier, the return on investment of a properly conducted LSA program can be manyfold over the initial expenditures in reducing support costs. This becomes apparent as initial support is looked at in Program B.

Company B has been able to translate its 30% improvement in reliability into a direct 30% reduction in initial support costs. Interestingly enough, the savings in initial support alone is around $38 million. This is a savings of over half the additional amount spent during the acquisition process. While the exact percentage in a real program might be open to debate, the point is that an improvement in reliability will reduce the number of system failures and, therefore, reduce the number of initial spares that are required to support the engine. Under the operations and support element, the same logic is applied to supply support and maintenance labor. For the sake of consistent analysis, the improved reliability also translates to a 30% reduction in the spare and repair parts and expendable material required. The improvement in maintainability and supportability also translates to a 30% reduction in maintenance labor over the life of the engine. The improvement will not be quite as noticeable at the unit level as it will at the other levels, especially depot, since the more expensive repairs are accomplished at other than the unit level. RM&S improvements amplify the savings at the depot level since fewer shop visits are required and, therefore, less maintenance labor is needed. The projected savings in O&S in Program B are about $88 million. This exceeds the entire increased cost in acquisition for Program B.

The largest LLCC element for an aircraft engine is the fuel, oil, and lubricants element. Through improved design characteristics, Company B was able to reduce its projected specific fuel consumption by 10%. Over a 20-year period, this would result in a savings of approximately $223 million in FOL costs—not an insignificant figure.

The "Other" LLCC element is certainly the most neglected one of the group. The military customer almost always finds funding for O&S and FOL since those elements keep the aircraft flying and operational. However, based upon my experience, inside and outside of the government, the sub-elements of "Other" are many times inadequately addressed and funded with insufficient monies. Both the government and the contractor assume the cost of these logistics elements will be low because they both want them to be low. When both sides discover that these costs are not low, there is much gnashing of teeth and wringing of hands.

(Continued on page 33)

PROGRAM A

YEAR	1	2	3	4	5	19	20	TOTAL	% OF TOTAL
RDT&E	**$ 24,860**	**$ 38,170**	**$ 35,970**	**$ 1,300**	**$ 1,300**	**$ 0**	**$ 0**	**$ 102,500**	**2.56%**
ACQUISITION				**40,396**	**64,844**			**957,882**	**23.94%**
LOGISTICS LIFE CYCLE COST	**1,289**	**8,446**	**32,683**	**49,203**	**46,468**	**224,558**	**225,716**	**2,940,809**	**73.50%**
LSA	**1,289**	**8,356**	**8,300**	**2,644**	**748**	**240**	**240**	**27,187**	**0.68%**
INITIAL SUPPORT				**6,243**	**6,539**			**126,981**	**3.17%**
OPERATIONS & SUPPORT				**7,577**	**10,987**	**23,048**	**24,333**	**294,544**	**7.36%**
SUPPLY SUPPORT				4,364	7,011	14,062	14,844	181,413	4.53%
SPARE & REPAIR PARTS				4,039	6,484	12,593	13,346	163,657	4.09%
EXPENDABLE MATERIAL				325	527	1,469	1,498	17,756	0.44%
MAINTENANCE LABOR				3,213	3,976	8,986	9,489	113,131	2.83%
FOL				**6,850**	**11,458**	**190,245**	**190,245**	**2,229,072**	**55.71%**
OTHER		**90**	**24,383**	**25,889**	**16,736**	**11,025**	**10,898**	**263,025**	**6.57%**
TECHNICAL PUBLICATIONS			16,050	9,591	2,453	512	438	44,216	1.11%
TRAINING			5,524	423	446	600	600	15,783	0.39%
FACILITIES			2,000	500	1,000	5,000	5,000	64,500	1.61%
COMPUTER RESOURCES			50	82	110	330	330	4,734	0.12%
PHS&T			50	110	210	1,289	1,317	13,691	0.34%
DESIGN INTERFACE				6,032	6,913	1,012	931	61,797	1.54%
SUPPORT EQUIPMENT		90	69	8,406	4,859	1,802	1,802	47,389	1.18%
MANPOWER & PERSONNEL			640	745	745	480	480	10,915	0.27%
TOTAL	**$ 26,149**	**$ 46,616**	**$ 68,653**	**$ 90,899**	**$112,612**	**$224,558**	**$225,716**	**$4,001,191**	**100.00%**

REPRESENTATIVE PRICES ARE IN FIXED YEAR DOLLARS (THOUSANDS OF DOLLARS)

Figure 3. Program A Life Cycle Costs.

PROGRAM B

YEAR	1	2	3	4	5	19	20	TOTAL	% OF TOTAL
RDT&E	**$ 24,860**	**$ 38,170**	**$ 35,970**	**$ 1,300**	**$ 1,300**	**$ 0**	**$ 0**	**$ 102,500**	**2.80%**
ACQUISITION				**43,224**	**69,383**			**1,024,934**	**27.98%**
LOGISTICS LIFE CYCLE COST	**1,397**	**8,695**	**30,873**	**39,758**	**36,035**	**196,247**	**197,043**	**2,535,971**	**69.22%**
LSA	**1,397**	**8,632**	**9,374**	**3,542**	**858**	**240**	**240**	**29,023**	**0.79%**
INITIAL SUPPORT				**4,370**	**4,577**			**88,885**	**2.43%**
OPERATIONS & SUPPORT				**5,304**	**7,691**	**16,134**	**17,033**	**206,023**	**5.62%**
SUPPLY SUPPORT				3,055	4,908	9,843	10,391	126,831	3.46%
SPARE & REPAIR PARTS				2,827	4,539	8,815	9,342	114,402	3.12%
EXPENDABLE MATERIAL				228	369	1,028	1,049	12,429	0.34%
MAINTENANCE LABOR				2,249	2,783	6,290	6,642	79,192	2.16%
FOL				**6,165**	**10,312**	**171,221**	**171,221**	**2,006,167**	**54.76%**
OTHER		**63**	**21,499**	**20,377**	**12,596**	**8,653**	**8,549**	**205,873**	**5.62%**
TECHNICAL PUBLICATIONS			14,445	8,632	2,208	461	394	39,794	1.09%
TRAINING			4,695	360	379	510	510	13,320	0.36%
FACILITIES			1,600	400	800	4,000	4,000	51,600	1.41%
COMPUTER RESOURCES			35	57	77	330	330	4,232	0.12%
PHS&T			35	77	147	902	922	9,584	0.26%
DESIGN INTERFACE				4,222	4,839	708	652	43,258	1.18%
SUPPORT EQUIPMENT		63	48	5,884	3,401	1,261	1,261	33,170	0.91%
MANPOWER & PERSONNEL			640	745	745	480	480	10,915	0.30%
TOTAL	**$ 26,257**	**$ 46,865**	**$ 66,843**	**$ 84,282**	**$106,718**	**$196,247**	**$197,043**	**$3,663,404**	**100.00%**

REPRESENTATIVE PRICES ARE IN FIXED YEAR DOLLARS (THOUSANDS OF DOLLARS)

Figure 4. Program B Life Cycle Costs.

A Case Study in Life Cycle Costing: The F-111 Avionics Modernization Program

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Introduction

Historically, the United States Air Force (USAF) has not conducted extensive after-the-fact validations of its cost estimates. This study investigated the validity of the analysis used to predict Life Cycle Cost savings of a major USAF reliability improvement modification. To accomplish this, the largest DOD aircraft modification to exclusively address reliability, the F-111 Avionics Modernization Program (AMP), was examined. AMP was an attempt to improve reliability of the highest failure system on the F-111, the Bombing-Navigation System. The study was designed to assess the validity of the original estimate used to justify AMP.

Background

Due to shrinking defense budgets, the United States military Services are increasingly shifting their attention to identifying, developing, and inserting new and more efficient capabilities into those systems currently fielded instead of purchasing entirely new systems. While this might not seem to be a revolutionary idea (the venerable and oft-modified B-52 stands out as a prime example), the emphasis of the thrust has been noticeably expanded. Instead of including only combat performance improvements (more bombs on target), enhancements to logistics performance are also being examined. Support cost reduction, in the form of improved reliability and maintainability (R&M), is now receiving equal consideration with combat capabilities when upgrading a weapon system. Since operational and support costs account for some 60% of a weapon systems Life Cycle Costs (LCC), improvements to a systems reliability and maintainability can yield significant savings. (6:37) Realistic predictions are therefore necessary for decision makers to properly assess this potential.

While heavy emphasis is put on predicting a modifications potential R&M performance and the resulting LCC, little if any attempt has been made to assess the accuracy of the original predictions through comparison with the actual R&M performance and costs being realized. As Twomey states:

> Because of the time it takes to close the validation loop, i.e., 5 to 10 years after a system has become operational, organizations tend to view validation efforts as mainly academic exercises that have little practical significance. Consequently, validation efforts are given low priority or are sub-contracted to outside consultants on an ad-hoc basis. (7:77)

Such was the case of the F-111 Avionics Modernization Program (AMP), which was the focus of this research. The F-111 AMP was initiated in 1982 as a result of a Strategic Air Command letter which identified a mission need to improve the reliability of the FB-111A Bombing-Navigation System (BNS). As shown in Figure 1, the BNS Mean Time Between Failure (MTBF) at that time was at 3.9 hours while the average wartime

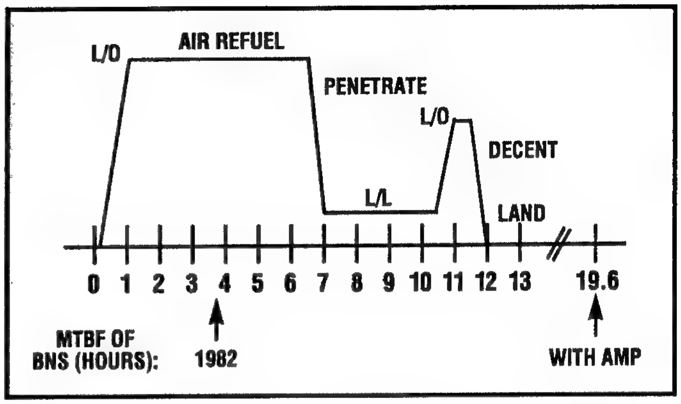

Figure 1. FB-111A Mission Profile Compared to Mean Time Between Failure of Bombing Navigation System.

sortie length for the FB-111A was anticipated to be 12.0 hours. AMP, as indicated, was expected to increase the MTBF to 19.6 hours.

Scope

This study addressed the issue of inserting more efficient capabilities into already fielded systems through a case study of the F-111 AMP. This program was chosen over other potential candidates for a number of reasons:

(1) AMP is the largest R&M modification ever undertaken by the United States Air Force (over $1 billion in acquisition costs).

(2) Mature R&M data is available.

(3) Both authors have experience with the aircraft.

(4) AMP provides an ideal example of a program reflecting the technology insertion theme.

The technical scope of AMP has changed significantly over time, as various subsystem modifications were either added or deleted. To mitigate the effects of this, a decision was made to operationally define AMP in the same manner as the original Independent Cost Analysis (ICA). This analysis was performed by the Financial Management Division of the Sacramento Air Logistics Center in 1986.

The study was designed to answer the following investigative questions:

(1) What were the original life cycle costs prior to AMP (baseline)?

(2) What were the expected life cycle costs due to AMP (prior to modification)?

(3) What are the actual life cycle costs due to AMP (based on current data)?

(4) Comparing these estimations, what are the major sources of differences between the expected and actual costs?

(5) What lessons/observations can be distilled from this case?

To limit the scope of this research, the F-111E, F-111F, and EF-111A were selected for analysis. The choice of these three Mission Design Series (MDS) was based on the ongoing retirement of all other F-111 MDSs from the AF inventory.

Data Collection

Data was collected as needed to run the AFMC Logistics Support Cost (LSC) model. LSC is a PC-based regression model requiring three input data files: System, Hardware, and Cost. Each of these files, in turn, consists of various data fields, with each representing a particular input variable. Data required for construction of input files for the pre-AMP (baseline) and post-AMP (prior to the actual modification) predictions were taken directly from the Independent Cost Analysis (ICA) files. The time frame for collecting data for the post modification prediction extended from 1988, when the first installations were completed on the F-111F, to 1991 (just prior to the major F-111 force restructure). Since installation of AMP occurred over a number of years and is still occurring for the F-111E and EF-111A, data were prorated when necessary to provide a more accurate assessment of actual AMP performance.

In preparing to gather the data for the post modification prediction, a number of potential sources were investigated in order to determine those sources which offered the best data from both an availability and quality perspective. For Mean Time Between Removal (MTBR) data, three primary sources were investigated: the G099 (Maintenance and Operations Data Access System - MODAS), the G063 (Reliability and Maintainability Information System - REMIS), and data collected by SM-ALC. MODAS and REMIS were found to be inadequate due to their inability to differentiate data associated with modified versus unmodified components. Discussions with SM-ALC revealed that a Mean Time Between Maintenance - Type One (MTBM-1, which includes inherent or internal failures) had been tracked on the majority of subsystems and several of the Line Replaceable Units (LRUs) affected by AMP.

While the data was not collected at regular intervals, it was AMP specific in its treatment of components, failures, and flying hours. Even though MTBR (required by LSC) is not the same as MTBM-1, it was felt that this MTBM-1 data would more accurately reflect MTBR than any other source. To be consistent, the most recent (highest flying hour) subsystem MTBM-1 value recorded for each MDS would be used as that subsystems MTBR. It was felt that since this value was the most recent and reliable indication of performance available and took into account all failures to date for that particular subsystem, it was the best number to use.

For other logistics related data, the D041(Recoverable Consumption Item Requirements System) was judged to be the best source since data was both available over the years of interest and was relatively easy to retrieve. Data available from the D041 included LRU unit costs, Depot and Base Repair Cycle Times, and Order and Ship times. Additional cost and logistics factors required by the LSC model were obtained from AFMCP 173-10 and Hq AFMC & SM-ALC project files, as necessary. In those areas where a reliable source of data could not be found, values used in the ICA-based files were retained.

Analysis

The main part of this analysis was a comparison of projected Operating and Support (O&S) costs encountered prior to AMP with those based, respectively, on predicted, and actual data (MTBR). To accomplish this comparison, the following LSC models were conducted for each MDS:

(1) Pre-AMP, or baseline, run.

(2) Post-AMP run, based on predicted AMP data (from the ICA).

(3) Post-AMP run, based on actual AMP data.

Our analysis basically proceeded along the following steps:

(1) Determine which version of LSC model to use.

(2) Prepare LSC model input data files.

(3) Conduct LSC model runs.

(4) Apply inflation rates and compute estimated O&S cost totals.

(5) Compute O&S cost savings using ICA and current data, respectively.

(6) Compare cost savings using ICA data with those using current data.

(7) Assess significance of findings.

Our first step was to assess the availability of support for the version of the LSC model originally used (v1.1), versus the suitability of using the current version (v2.2a). As it was determined that support for version 1.1 was unavailable, version 2.2a was used exclusively in the analysis. Using input data from the ICA, output from LSC version 2.2a was compared with output from LSC version 1.1. On the basis of discussions with the office charged with maintaining the LSC model (Hq AFMC/FMCA), differences noted were attributed to changes made to the model's internal parameters between LSC versions 1.1 and 2.2a.

Model execution required the construction of LSC model input files consistent with those of the original estimate. Three files for each MDS were required for each run: System, Hardware, and Cost. The System file contains logistics and operations parameters applicable to an entire MDS. The Hardware file, on the other hand, quantifies the differences in configuration (including differences in R&M data) amongst the different MDSs. Finally, the Cost file provides the average unit cost for each component to be used in computing spares costs.

The first two sets of LSC model runs described above (pre-AMP and post-AMP using the ICA data) made use of the original ICA data files. By referring to a copy of the User Documentation for version 1.1, it was discovered that most data fields, while arranged differently, were identically defined by both versions. (1) Exceptional data fields required minimal assumptions to reformat. To construct the third set of data files (for the post-AMP, current data runs), the post-AMP ICA data files were used as templates. Each data field was assessed as to whether more accurate (current) data was available; if not, the original ICA data was retained.

LSC model output for the nine runs was adjusted for inflation using the current DOD raw inflation indices, for a base year of 1994. (3) These costs were then summed over the current anticipated life span of the MDSs studied. Total summed costs for the post-AMP (ICA data) and post-AMP (current data) runs were each subtracted from that of the pre-AMP run. This yielded the estimated cost savings based on the ICA data and the current data respectively. Then, the two cost savings estimates were compared to determine the degree of over/under estimation of the ICA data based run. Finally, the significance of the findings in light of the operational performance improvements made possible by AMP (excluded from our analysis up to this point) and potential cost savings not fully realized by the Air Force were assessed. As LSC's inherent output variance could not be quantified (or bound, to any reasonable degree), statistical tests

of significance of the model's output were not possible. Instead, the authors made a subjective judgment as to the strength of the results.

Findings and Conclusions

In examining the results of the analysis (see Table 1), it was evident that the predicted costs savings based on the ICA data were significantly lower than those based on actual (field) data. Therefore, a conclusion was reached that the ICA data underestimated the logistics support costs savings of AMP.

	PRE-AMP	POST-AMP: ICA	POST-AMP: CURRENT	ICA SAVINGS	CURRENT SAVINGS	DELTA
EF-111A	$181.3	$122.6	$10.2	$58.7	$171.1	$112.4
F-111E	246.1	167.6	13.0	78.6	233.2	154.6
F-111F	127.4	83.1	1.5	44.2	125.8	81.6
TOTAL	554.8	$373.3	$24.7	$181.5	$530.1	$348.6

Table 1. Operating and Support Cost Summary (Base Year 1994 $ in Millions).

While a formal sensitivity analysis was determined to be impractical because of the sheer number of data fields which could be varied, the authors did qualitatively identify a number of possible sources which might account for the increase in predicted cost savings. First, this rather large difference can most likely be attributed to better than expected improvements in several key variables which are used by the LSC model. Better reliability in the form of higher MTBRs than expected is one such source. The majority of LRUs were found to be experiencing MTBR values that were better than originally anticipated. Fewer removals will result in reduced pipeline costs (shipping, packing, and depot maintenance costs will be lower). Another source involves the fact that the majority of AMP LRUs were eventually coded so that condemnations could only occur at the depot. This differed from the original ICA, which assumed that condemnations at the base level could also occur. When combined with significantly lower than expected depot condemnation rates, lower costs as predicted by the model will result since fewer replacements will have to be purchased.

Another aspect involving the difference between ICA predictions and actuals lies in the fact that the current savings are approximately three times the savings as predicted by the ICA. From this, we can speculate that even if some of the data used in the post-AMP current analysis were inaccurate, these inaccuracies would have to be extremely large to affect a change in the overall conclusion that the logistic support cost savings were originally underestimated. Finally, based on the authors' personal experiences, this underestimation is rather surprising in that Air Force programs usually struggle to achieve the R&M and other related logistics performance goals that they set at the start of a program. For AMP, this was apparently not the case.

In a broader sense, one must also realize that AMP has likely affected the F-111 in positive ways beyond just those cost elements addressed by the LSC model. One such area would be manpower. Because the LSC model does not consider manning levels and their associated costs, it ignores the fact that increased reliabilities and maintainabilities resulting from improvements such as AMP can reduce the personnel required to maintain the aircraft. Another area that also needs to be considered is AMP's improvement to F-111 operational effectiveness. Since overall reliability of the Bombing Navigation System has been improved, the probability of a particular aircraft completing its mission has also increased. This impacts mission planning since fewer backups are necessary to insure mission success (essentially a force multiplier effect). In addition, AMP also expanded the functional capabilities of the BNS making the F-111 a more formidable foe in the air—something that is extremely difficult, if not impossible, to put a price tag on. Combining these factors with the costs savings being achieved leads us to conclude that AMP is a noteworthy example of a successful program.

Recommendations

Perhaps the strongest recommendation that can be made as a result of this study is that other weapon systems should be analyzed in the same way. By doing this, a database addressing the accuracy of support cost predictions could be built. This database would serve as a basis for establishing a range of expected differences (either positive or negative) when predictions are compared against actuals. This, in turn, could eventually be used to calibrate the LSC model, to increase the accuracy of future predictions. This would allow decision makers an added degree of confidence when assessing the potential cost savings of a particular modification.

As pointed out by Twomey, few organizations ever go back and validate their original estimates. (7:77) Validations should be required, not only to assess whether anticipated logistics cost savings are actually being realized, but also to serve as a means of accountability. In order to accomplish these validations on a timely and accurate basis, two changes are necessary. First, the program office needs to plan early as to what data are needed and when, with specific attention to data availability through existing databases. As was the case in this study, it was only through data tracked and recorded by SM-ALC that a support cost validation analysis was possible. Second, the Air Force needs to assess its databases (MODAS and REMIS) to identify improvements which might aid accomplishment of these validations. Probably one of the first steps needed is to insure that the data gathered is kept for a minimum of ten years to allow for a comprehensive analysis. For instance, the two-year limit on MODAS (and its lack of an archive copy) makes it useless for the long-term analysis required by a validation. Another step which could aid in the validation effort would be for the databases to distinguish between maintenance actions on a modified unit versus its predecessor. A simple change in Work Unit Codes (WUC) could enable the phase-in period of a new modification to be monitored more easily. This, in turn, would not only assist validation, but it would also assist in problem identification and associated correction.

One of the more interesting features of the LSC model is its allowance for reliability growth during phase-in and maturation of the system under analysis. While there exists a strong theoretical foundation for establishing a reliability growth profile (slope), these curves are primarily based on test results; operations and maintenance learning curves are disregarded. During this study, a wealth of failure data was discovered which might be used as a start toward establishing reliability growth relationships based on field data. In addition, such a study might uncover trends regarding the duration of growth (time to maturity) which might prove helpful in logistics planning.

Overall, the general impression of the authors was that the LSC model is an extremely well-formulated and comprehensive

model for analyzing support costs. However, during the course of this study, several ideas for improving the LSC model emerged. First, efforts should continue to increase the user friendliness of the model. This could be accomplished in a number of ways including modifying the model so it will support a variety of operating systems other than just MS-DOS. Versions compatible with the Windows and Macintosh operating systems would not only make it easier to use, but would probably encourage increased use of the model due to the prevalence of these operating systems on today's personal computers. Another way to increase user friendliness would be to develop a captioned spreadsheet format for input data. This would speed data entry, reduce data entry errors, and allow for easier manipulation of the data fields. Finally, the LSC model should be modified to take into account both DOD inflation indices and anticipated life span interval. As it now stands, one must go off-line to conduct inflation analysis. This acts as an impediment to doing sensitivity analysis because of the time required to modify LSC output data so it can be used for analysis at the aggregate level.

Summary

This study was able to show that the F-111 Avionics Modernization Program is yielding greater savings in logistics support costs than originally anticipated. When combined with a probable decrease in manpower needs, better operational effectiveness, and increased functional capabilities, it can easily be said that AMP stands out as an example of a successful program. More studies, however, need to be conducted in order to establish heuristics which program managers can apply in evaluating future programs. Improvements in planning, database structure, understanding reliability growth relationships, and the LSC model would make validation of support cost estimates more accessible. More timely insights to both program progress and success would provide managers the tool they need to accurately assess the cost impacts of their decisions.

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Career and Personnel Information

Logistics Professional Development

Logistics Cross Flow

The Air Force Logistics Board of Advisors (BOA) met in April 1994 and decided to eliminate the formal Logistics Officer Professional Development (LOPD) program. Instead, they made it the responsibility of the unit senior logistician (Logistics Group Commander at the base or Director of Logistics at a depot or center and at the MAJCOM staff) to ensure logistics career broadening opportunities are made available. While each BOA member agreed that future logistics leaders will need experience in more than one logistics AFSC, they felt a formal program was not needed under the Officer Voluntary Assignment System (OVAS). So if you are interested in broadening into another logistics AFSC, you can do so through your unit senior logistician or by volunteering for an assignment under OVAS.

Another way to cross flow is through the AFIT program. The areas of transportation, supply, maintenance, and logistics plans have approximately 30 AFIT quotas to fill for FY95. If you are interested in the opportunity to earn a master's degree in these career fields, contact your MPC assignment team for more details. For those officers cross flowing through AFIT, their next assignment will be to a billet requiring an officer with an advanced academic degree. Presently, the majority of transportation positions are in Air Mobility Command while the remainder of the logistics positions are within either the Air Force Materiel Command headquarters or at the air logistics centers.

Joint Duty/Agency Assignments

The method AFMPC processes joint duty and joint agency assignments has changed effective 1 June 1994. Like the rest of the Air Force, AFMPC has been challenged to do more with less. As a result of this challenge, AFMPC leadership saw the unique opportunity to improve customer service and to eliminate manpower positions at the same time by combining all joint rated and mission support assignments under one division chief. This realignment means that DPMRJS (DSN 487-4455/4941/ 6261/6507) will now act as the assignment authority for all joint duty/agency positions. They will receive the unified commands' requisitions, post the Electronic Bulletin Board advertisement, and work with the unified commands to assign prospective candidates. In past years, if an officer wanted to be considered for a joint billet he or she contacted their functional assignment team. These days are gone. However, the benefits outweigh the inconvenience: (1) unified commands now have only one officer to work through to get their positions filled vice the previous 40-plus assignment teams; (2) having a small core of joint assignment officers means fewer people require training on the peculiarities of joint assignments ultimately resulting in more consistent information passed to prospective candidates; and (3) a single function now has visibility of all joint billets across all AFSCs.

Assignment Management System

The Assignment Management System (AMS) is the latest upgrade to our assignment tracking system. We recognized the need to upgrade our information handling when officers began volunteering for a number of assignments outside of their AFSC. Inadequate tracking of assignment information meant four or five teams were often attempting to work assignments for the same individual. This resulted in frustration when the teams' "best matches" were assigned, or in the process of being assigned, to another billet. Our new AMS allows an officer to call any assignment officer and enter his or her name for assignment consideration. Other assignment teams will have visibility of the status of the officer's assignment. Once an officer is selected for assignment, his or her name will be highlighted and the AMS will prevent another assignment team from making further assignment actions. Future plans are to upgrade the AMS to send an e-mail or facsimile message to each potential candidate, both select and non-select, regarding assignment status upon assignment closeout.

Personnel Update

Some recent changes have taken place in the Logistics Support Officer Assignments Branch at the Air Force Military Personnel Center (AFMPC). The present logistics team (DPMRSL) is comprised of transportation, logistics plans, and supply officers. Major Cheryl Heimerman is the team chief and the team members are: Major Dennis Crimiel and Captain Craig Bond, Supply Officer Assignments; Captain Rick Cornelio, Logistics Plans Officer Assignments; and Majors Heimerman and Toby Seiberlich, Transportation Officer Assignments.

The Aircraft and Missile Maintenance Assignments Branch (DPMRSM) is led by Major Mark Atkinson. Team members are Major (S) Steve Shinkle and Captains Catricia Mills and Roger Rostvold.

Officers Wanted

The Air Force needs logistics officers to fill joint duty billets requiring foreign language expertise. Current fluency in a language is not absolutely essential because officers selected as the "best match" for these assignments will be sent to a six-month language course at Monterey, California, en route to the assignment. However, in order to compete for these assignments, officers must take the Defense Language Aptitude Battery (DLAB) through their local base education office. These joint billets are an excellent opportunity for professional growth and a chance to get joint duty experience as well.

Air Force officers with Joint Operation Planning and Execution System (JOPES), Joint Operation Planning System (JOPS), and Worldwide Military Command and Control System (WWMCCS) experience are also in demand. It is crucial for successful joint deliberate planning that the Air Force maintain a core of officers capable of managing these planning systems. Contact your MAJCOM functional managers to sign up for appropriate training courses.

(Lieutenant Colonel Dave Smith, HQ AFMPC/DPMRSC, DSN 487-5788)

USAF Logistics Policy Insight

Regulations Are Out! Policy Directives and Instructions Are In!

Since President Clinton took office, we have heard a lot about reinventing government and making it work better. Vice President Gore was given the task to make it happen. In order to determine where government could be improved and streamlined, Mr Gore commissioned the National Performance Review (NPR). Each agency in the federal government was directed to review the way it conducts business and recommend a plan for improvement. One area identified as needing improvement was directive or regulatory documentation—there was too much. We not only needed to reduce the number of regulation, we needed to reduce the amount of guidance in these documents and give the "users" more flexibility in the way they implement and conduct their business.

To comply with NPR guidance, the Department of Defense (DOD) assembled a staff under the direction of Lieutenant General McInerney, Air Force Vice Chief of Staff, to conduct the Defense Performance Review (DPR). The DPR provided the inputs necessary to construct a plan for improving the operation and efficiency of the DOD. The Air Force was already moving in this direction. Specifically,. General McPeek had already directed a review of Air Force regulations. The intent was to separate policy from procedure and to measure how well policy was being implemented. Policy, the "what to do," would be developed at the Pentagon, and policy implementation, the "how to," at the MAJCOMs and field Operating Agencies (FOAs). Thus, Air Force Policy Directives (AFPDs or PDs) and Air Force Instructions (AFIs) were born. This was a radical quality process improvement. The MAJCOMs/FOAs now had the opportunity to play a major role in deciding for themselves how they would implement headquarters policy.

AFPDs are the "Objective Regulations." The content of the PD is limited to policy statements, explanations of key terms, responsibilities and authority, policy interfaces, and CEO-level metrics to measure the success of the policies. As a goal, the length of a PD is two pages. Attachment 1 to every PD describes the metric(s) and provides sample graphics. Procedures or detailed "how-to" instructions do not appear in the PD. Only overarching policy is to be incorporated into the body of the PD. PDs are authored at the Pentagon and may not be supplemented.

AFIs are implementing procedures, and as mentioned, are created at the MAJCOM/FOA level. They provide specific, detailed procedural guidance necessary to implement Air Force policy in the field. AFIs reference the AFPD(s) they implement. Some AFIs are written at the Secretariat/Air Staff level if the subject does not apply to the field or no other agency is available to write it. These instructions must be approved by the HQ USAF functional OPR and are issued by HQ USAF. AFIs may be supplemented at any level to incorporate MAJCOM- or base-specific information necessary to fully implement the PD. Every process the Air Force uses to make decisions has come under scrutiny and made more effective and efficient.

Another change from the old Air Force Regulations (AFRs) is the numbering system. AFPDs and AFIs are numbered to correspond to the AFSC of the specific functional area they address. The two-digit prefix of an AFI or PD is the same as its functional AFSC. For example, the Logistics Plans career field is now the 25XX(X) AFSC. Likewise, logistics PDs and AFIs have a "25" prefix. Our PD on Support Agreements is 25-2 and its implementing AFI is 25-201. Supply is a "23" AFSC with PDs and AFIs having a "23" prefix; transportation is a "24" prefix; and maintenance is a "21."

Needless to say, it will take some time to get accustomed to these new documents and numbering system. As this article is being written, the overall conversion to AFIs is nearing completion. There will be about 165 AFPDs and 690 AFIs totaling less than 17,000 pages compared to the previous 1,510 regulations and 46,000-plus pages. As AFIs are published, and we begin actually using them, there will surely be some problems, errors, and inadequacies found. We expect this, and those identified discrepancies will be fixed in future revisions or via interim change messages.

The AFPD and AFI initiative goes beyond separating policy and guidance. All the new Air Force publications will be contained on a Compact Disk-Read Only Memory (CD-ROM) and eventually publications will also be on disc. The first publication of the Air Force documents on CD is scheduled for release this summer. A new disc will come out every three months as more AFIs get published and changes are needed. The Air Force publications system will become entirely paperless. Over 10,000 CD-ROM disc readers are already available USAF-wide, and many users will be able to access the new publications directly from their local area network (LAN).

The development of the AFPD/AFI concept and its implementation has been an intensive effort. Many people across the Air Force have been involved with the review of AFRs, making recommendations for change, writing new documents, revising them, editing, reviewing, coordinating, and publishing. The project has been successful—so successful in fact, that the Air Force was singled out in the NPR as the model program for the entire Federal Government for the reduction of regulatory documentation. Once again, the Air Force is at the forefront, leading the way! (Major Pete Dering, AF/LGXX, DSN 227-1429)

Minimum Mission Capable Rate

The current thinking on the minimum mission capable (MC) rate a weapon system must obtain is subjective. The minimum required MC rate is necessary because it is used to determine the relative "health" of the weapon system and it is also used to compute the aircraft availability rate for use in the reparable spares requirements computation.

The peacetime minimum MC rate for each weapon system is computed using a typical squadron flying utilization (UTE) rate. The wartime minimum MC rate, on the other hand, is calculated using the Tactical Logistics Assessment Model (TLAM) and Airlift Logistics Assessment Model (ALAM). These models determine what MC rate would be required to satisfy wartime sortie requirements. The higher of either the peacetime or wartime calculations is designated the minimum required MC rate. (Major Mark Humphrey, AF/LGMY, DSN 227-9232, Major Randy Moller, AF/LGSI, DSN 225-6730)

Increase in Threshold for Items Purchased in the O&M Accounts

Congress has responded to DOD's desire for increased funding flexibility and has increased the expense/investment threshold effective 1 October 1994. As part of the FY 94 DOD Authorization/Appropriation Acts, the threshold criteria increased from $15,000 to $25,000. In response to the threshold increase, funds were transferred from the 3080 procurement appropriation to O&M for fiscal years 1994-1999. Some of the affected programs in 3080 are Base Procured Investment Equipment (BPIE), Productivity Enhancement, Environmental Projects, and Closed Circuit Television projects. Although the $25,000 threshold will provide commanders added flexibility, it also shortens the obligation period for those items to 12 months vice the three-year availability of 3080 procurement funds. Regardless of appropriation, however, timely execution of funds remains a criteria for approval of future budget requests. Bottom line: you have to spend it to get it! (Scott Reynolds or Major Gary Gibbs, AF/LGSP, DSN 225-7749)

(Continued from page 24)

Through the LSA process, Company B was able to reduce the costs of technical publications 10% and training 15%. Both of these sub-elements are highly dependent upon a proper LSA being conducted to keep costs low. The cost of facilities was projected to be reduced by 20%. This figure was based primarily upon the number and size of depot facilities required to support the engine. Reduced maintenance requirements at the base level also allowed for some sharing of maintenance facilities which reduced unit facility costs. Computer resource costs were projected as being identical with Program A since the number of total units would still be the same with either program. PHS&T, design interface, and support equipment costs are estimated to be 30% less than Program A because of the design and RM&S improvements which reduce the requirements in each of these sub-elements. Lastly, the manpower and personnel sub-element in Program B remained the same as Program A since the number of ILS management and other required, but not easily categorized, people remained low.

When "Other" is totaled, a savings of almost $58 million is achieved in this category in Program B over the same category in Program A. This brings the total logistics life cycle cost savings of Program B to $405 million over Program A. Once the additional acquisition cost is subtracted out of the Program B savings, the total life cycle cost savings is $338 million. The program manger who looks at the total life cycle cost picture will see that the logistics life cycle cost savings in Program B make that program a better choice on just price alone. When the benefits of a better design are figured in, Program B is the obvious choice for production.

Summary

A logistics life cycle cost matrix for a system is important to both the customer and the vendor when the price of integrated logistics support is being computed. It provides a systematic approach to estimating the cost of a fielded system for:

(1) Pre-contract award analysis.
(2) Establishing criteria for source selection.
(3) Conducting cost-benefit analysis/trade study evaluations.
(4) Post-contractor award analysis.

This guide provides a program manager with a broad overview of the factors that must be considered when estimating system integrated logistics support costs and a framework within which to compute them. Logistics is now receiving more attention at the beginning of a program than it has in the past. But, being identified as an important part of a program and being treated as an important part of a program may be two different things. If a credible method of estimating logistics costs can be found, then the customer and the program managers involved will have confidence that what they are being told is true. Hopefully, this discussion of logistics life cycle costs and the LLCC matrix will go a long way towards providing all concerned with at least one workable method for estimating a system's logistics costs.

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Logisticians in War: The Experiences of Special Teams in the Vietnam Era

H.P. Carlin

The Supply Teams

By early 1965 both the Air Force Logistics Command (AFLC) and the Pacific Air Forces (PACAF) were aware that the massive buildup of supplies and equipment in Vietnam, known as Project Bitterwine, would soon overwhelm existing supply mechanisms and that any solution to this problem would require unusual measures. As a first step, PACAF asked AFLC in April 1965 to send a team of supply experts to Southeast Asia to "prevent development of many trouble spots at a later date." Since the team was to be drawn from AFLC manpower resources (this would not be the last time PACAF insisted that it lacked manning for such an enterprise), and because AFLC was composed of mostly civilians, PACAF in effect was asking the logistics command to take the unprecedented step of sending civilians into a combat zone—since all of South Vietnam was a combat zone. Even in World War II the Air Service Command had not tried to do that. (1)

Upon receiving PACAF's request, AFLC granted its field units the authority to send civilian volunteers to Vietnam, and by the spring of 1965 the logistics command had placed a small number of these overseas on short tours of duty. But the AFLC commander, General Mark E. Bradley, Jr., knew that USAF units in that area of the world needed far more than a handful of supply technicians. And so at the end of May 1965, he proposed a bold idea to his counterpart at PACAF: AFLC would send to war not individuals, but entire teams of supply technicians—ranging in size from 15-25 people, moving from base to base wherever they were needed. (2)

In the days following this proposal—in effect the announcement of a major new logistics policy—the task for General Bradley and his staff was to turn a concept into a reality. Their approach was to draw up tentative guidelines. Later, the command would refine the guidelines and make them more detailed. (These guidelines never evolved into a formal master plan but were changed gradually over the next several years to reflect the experiences of the teams in the field.) When they were first issued, the rules were relatively simple: General Bradley expected each air materiel area (AMA) to appoint at least ten experienced persons, including both military and civilians, to a special unit known as a Rapid Area Supply Support (RASS) team, the mission of which was to come to the aid of any USAF base in Southeast Asia that required extraordinary help in carrying out its supply function. These teams were to be prepared to depart overseas within 18 hours after receiving a request for assistance. They were to be deployed on temporary duty for a maximum of 90 days at each base; team members would include two general logisticians and eight warehousemen experienced in shipping and receiving. Finally, as much as possible, AFLC wanted each team to be manned predominantly by military personnel, under the leadership of a lieutenant colonel; any civilian members would of course be strictly volunteers. (3)

Having issued guidelines to set up what was essentially an experiment, AFLC dispatched the first of many RASS teams to Southeast Asia. But after only a few months, the needs of PACAF and circumstances in the field forced the first of many changes. At the end of October 1965, PACAF asked AFLC for a 100-man team to serve the newly-activated bases at Cam Ranh Bay and Phan Rang, and for a 33-man team to assist in the expanding operations at Don Muang, Korat, Takhli, Udorn, and Ubon. In response, AFLC directed its field units to increase the size of their RASS teams from 10 to 60, and then proceeded over the next month to draw up a new set of instructions, more complete than the original and, in some respects, quite different. In view of projected workloads and the inherent problems of placing civilians in combat areas, AFLC decided to establish at each air materiel area two 60-man RASS units, one entirely military, the other entirely civilian. These units would constitute a manpower pool from which RASS teams could be formed and deployed whenever needed. Moreover, each of the military and civilian units would be 20 percent overstrength to allow for such contingencies as transfers, temporary duty, travel, and leave. (4)

AFLC made two other key decisions on the structuring and operation of the RASS teams. First, the command intended to use the military teams in combat zones and the civilian teams in non-combat zones. This meant, in theory, that military teams would be deployed to Vietnam, Thailand, the Philippines (but not Clark Air Base), Taiwan, Korea, Turkey, and Greece; civilian teams would be sent to bases in the CONUS, Clark Air Base, Okinawa, Japan, Hawaii, Europe, and South America. Secondly, AFLC had each AMA establish control over its own RASS cadre by appointing a civilian monitor (GS-12 or 13) to run the civilian cadre, and a major or lieutenant colonel to manage the military cadre. AFLC also assigned each air materiel area a zone of geographical responsibility for RASS activities. For the Pacific region this responsibility fell to the Sacramento Air Materiel Area. (5)

The deployment of the RASS teams between 1965 and 1968 approximated but did not precisely follow the formal guidelines laid down by AFLC at the conception of the program. This was understandable inasmuch as the initial guidelines were not based on actual experience, but were issued in the first place to get the program started. From the outset it was obvious that the very nature of the RASS teams was an unusual experiment designed to overcome a critical problem in the midst of war—itself the most unpredictable of phenomena. It is hardly surprising, therefore, to find that the actual experience differed in varying degrees from the model, that within the limits of the law, the guidelines were not as important as the imperative to help PACAF, and that PACAF's needs were unpredictable and constantly changing.

To be sure, the work itself was predictable and not especially varied, for the RASS teams and their counterparts in transportation (Rapid Area Transportation Support or RATS) all performed the same basic tasks wherever they were assigned.

These consisted of performing detailed inspections and inventories, establishing proper records and amending those that had been improperly filled out, returning reparable and serviceable items to the Air Force supply system, packing, crating, and moving supplies from outside storage into warehouses, and helping to redistribute excess materiel. As for the RATS teams, their primary job was to eliminate shipping backlogs, improve packaging procedures, and institute measures for the systematic processing of supplies. (6)

Thus it was not the nature of the work but the circumstances of war and the changing needs of PACAF that rendered futile AFLC's early attempts to impose standards on the size, composition, and functioning of the supply and transportation teams. Just a glance at the various teams operating in Southeast Asia between 1966 and 1968 reveals diversity, not uniformity. One would see, for example, a master sergeant leading a 12-man team at Takhli Air Base for 90 days; a team of 25 deployed to Tuy Hoa, and another of the same size deployed to Pleiku; a team of 40 airmen on extended duty at Cam Ranh Bay, followed by another 40-man team sent to that site not all at once but in groups at a time. (7)

The diversity of the RASS teams was not so much a problem as the symptom of a problem—an indication that AFLC had a long way to go before gaining a firm grip on its supply units in Southeast Asia. Problems were legion, but it should be said at the outset that many of them were beyond the control of the logisticians at the home bases in the United States and those at overseas bases. And while these problems were clearly serious, it is also true in some cases that the cause of the problems was a matter of dispute among contemporaries and even now is not clear to historians. It is easy to find allegations but more difficult to find substantiations as to what went wrong. For example, in the summer of 1966, a team chief at Takhli, in this case a sergeant, complained that AFLC had failed to define the mission of his team, thereby causing confusion over the need for or purpose of this unit. The same sergeant also claimed that host supply personnel stopped work when the RASS team arrived, thus making the team's job harder than ever. In the opinion of Major General C.W. Cecil, Commander of the Sacramento Air Materiel Area, there was sufficient basis for the allegations to warrant further investigation. But even if nothing came of this particular case, General Cecil recommended several measures to strengthen the effectiveness of the RASS teams:

> Previous experience in the employment of RASS . . . teams also indicates that where an enlisted man is the team chief, base officials have on occasion directed the team members to assume tasks foreign to their mission and/or skills. These situations did not occur where the team was headed by an officer or Civil Service employee. To assure that teams are employed for their intended purpose, regardless of the rank of the team leader, it is recommended that the team travel orders include a statement that the team chief is the representative of the AMA Commander, and direct communication with his home base is authorized. It is further recommended that, wherever possible, HQ AFLC instructions to the monitoring AMA contain a statement as to the team's mission in order that this information may be included in the orders. (8)

General Cecil's advice was translated into command policy in October 1966; thereafter, all team leaders were either high ranking civilians or military officers. Also, to prevent confusion over mission responsibilities, AFLC directed its liaison officers to strengthen ties to RASS units in the field. But these measures did not end the problems, which ranged from trivial to severe. The RASS teams, for example, sometimes lacked their own transportation to and from work, which was more than an inconvenience and resulted in many lost hours. Nor was it efficient that many team members were unfamiliar with the UNIVAC 1050-II computer, a crucial tool for the supply system and one used at several of the bases in Southeast Asia; learning to use that system also cost hours of work. (9)

Other problems facing the RASS teams were more serious, and these too were widely varied. To begin with, there was the sheer physical challenge of dealing with a massive amount of materiel, most stored outside and already corroding long before the RASS teams arrived. As one team leader observed, "Corrosion and rust are acute in SEA [Southeast Asia] and have caused deterioration to the extent much of the property has to be salvaged." (10) In their haste to move supplies into warehouses, RASS teams did not always have time to wait for the overworked civil engineers, and sometimes supply personnel were the ones to construct the storage bins. The RASS teams further had to contend with the fact that the base supply function was undermanned, a problem at times so severe that team leaders thought they could never be effective unless the supply function was given more men. (11)

Another complaint of the team leaders focussed on the composition and skill distribution of the team members. One leader, for example, observed that his team lacked the skills to prepare equipment for outside storage. Another noted that his personnel had too many high grades and too many inventory management specialists. This same leader also stated: " . . . we had a situation whereby more people were working out of their skills than in them . . . many people were being paid a great deal of money to perform unskilled manual labor tasks." (12) Yet another leader, assigned to Tuy Hoa in the summer of 1968 reported that his team did not have enough foremen, with the result that "the narrow range of skills and restricted experience required constant and detailed supervision." (13)

Living conditions in Southeast Asia also presented problems, especially to civilians. Placing civilian volunteers in a combat zone was a matter of policy, but what happened to them once they got there was largely a circumstance of war. Airmen and soldiers could expect to encounter hardships and endure, but the same was not necessarily true for civilians. No matter how much they knew beforehand, some civilians could never get used to their life overseas. In fact many civilians found living conditions almost unbearable. If one allows for exaggeration, their accounts still paint a grim picture of leaky roofs, filthy rooms, no hot water, inadequate messing facilities, no transportation to work, not even lockers, pillows, or blankets. But it must also be said that these conditions were rarely permanent; more often than not the host base was simply not prepared in the midst of war to receive a RASS team, and usually within a few days of their arrival the visitors were provided adequate facilities and supplies. (14)

Though frustrating, the living and working conditions in Southeast Asia were not the main obstacle to accomplishing the mission. The main problem was that there was too much work for the limited number of people assigned to the supply function. Essentially this was an insoluble problem and one that tormented both AFLC and PACAF for the duration of the RASS program. If PACAF had changed its priorities and placed more personnel in the supply function, or if AFLC had had large numbers of qualified volunteers to send overseas for long periods of time, both commands could have better coped with the demands of the supply operation. But this was not the case.

PACAF's plight was that it was unable to commit more manpower to supply operations, even as support for the tactical

forces was degenerating. All too often, PACAF found, the RASS teams were effective only when they were in place; when they left, the original problems returned and conditions were as bad as ever. Furthermore, as the PACAF DCS/Materiel, Major General Charles G. Chandler, observed, the situation of the tactical units was fluid; new deployments, unit movements, and increased flying hours all added extra burdens to supply operations. And without an increase in manpower, General Chandler feared the USAF's supply capabilities in Southeast Asia would be severely hampered. (15)

General Chandler's remarks were more than an observation, they were intended as a solicitation for more RASS personnel. But by the summer of 1967, AFLC was finding it difficult to recruit civilian volunteers for the RASS program, and even more difficult to match the ever higher numbers PACAF was asking for. Furthermore, the logistics command believed that it had contributed more than its share of supply manpower. Thus far, RASS teams had made over 30 visits to bases in Southeast Asia, providing almost 400 man-years of assistance since the inception of the program in 1965. Such support would continue, vowed General Thomas P. Gerrity, but this AFLC commander also believed that a perma- nent solution to supply problems would require a more substantial contribution by PACAF. Eventually the two commands were able to work out an agreement on manpower contributions, although PACAF stopped asking for supply personnel only when the US began withdrawing from Vietnam. (16)

It is clear, then, that the RASS teams represented a considerable investment on the part of AFLC—in 1968 alone that command spent more than $700,000 deploying 443 men to Pacific bases—but what is not so clear is whether these teams were really effective. Did they achieve their goals? The answer is ambiguous, but in brief one could say that while a team was in place at a particular base it was an effective remedy, but once the team left, the patient invariably suffered a relapse, which in no way was the fault of RASS personnel. As one AFLC commander, General Kenneth B. Hobson, observed, if there was to be blame, it could be attached to base supply management, not to the visitors who tried to help out. The Sacramento AMA commander, Major General William W. Veal, summed it up best when he noted: "after a RASS/RATS team departs from a base, a new request is often submitted for another team to maintain a continuing capability to perform normal supply functions." (17)

The Maintenance Teams

The other large and predominantly civilian Southeast Asia support program established in 1965 was also a direct outgrowth of the rapid buildup of US forces. Before the buildup, contractors in Southeast Asia had no trouble in accomplishing most of the repair work on damaged aircraft, but when the air war began to intensify, the number of crash- and battle-damaged aircraft increased beyond the contractors' ability to repair them, which of course was alarming both to PACAF and to AFLC. One possible solution was to ship the damaged aircraft back to the United States, a distance of 10,000 miles, but for obvious reasons that alternative was not attractive. Realizing that his command would have to try an entirely new approach, General Bradley instructed his staff to devise a plan that would give PACAF whatever help was needed. In doing so, the logistics command would not be limited to its traditional role of providing technical advice. (18)

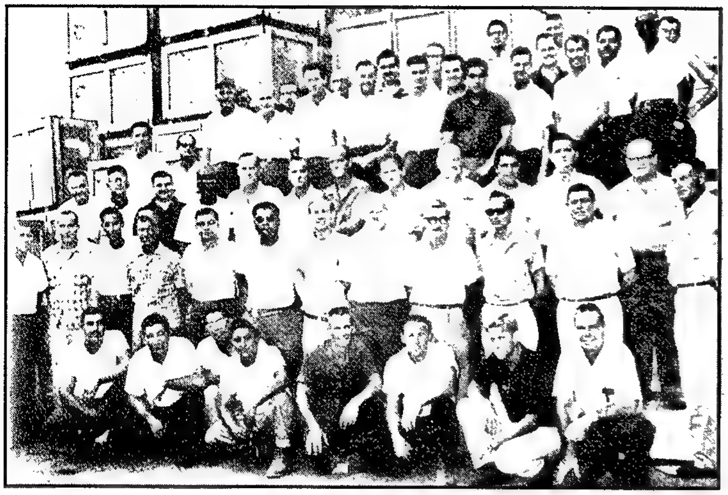
On General Bradley's instructions, AFLC maintenance officials concentrated in December 1964 on four options: (1) establishing mobile maintenance teams; (2) using mobile shop vans; (3) converting mothballed Navy carriers into floating repair docks; and (4) setting up permanent depot-level maintenance squadrons at the air materiel areas. After some discussion, the logisticians rejected the maintenance van and floating dock alternatives as too costly and agreed that the maintenance squadron option needed further study. That left the first option, the use of mobile repair teams, and it was upon this concept that the logisticians developed the command's aircraft recovery and repair program. (19)

Over the next several months AFLC planners refined the mobile repair team option into a detailed plan, the main features of which addressed the mission, organization, and deployment of special units known as Rapid Area Maintenance (RAM) teams. According to the plan, RAM units would be deployed wherever they were needed to perform depot-level maintenance on damaged aircraft. It would also be the mission of the RAM teams to assist in disassembling and preparing for shipment those aircraft that could not be repaired on site. Although planners wanted to use military personnel as much as possible, they knew that RAM teams would have to draw on the special skills of civilian volunteers. The typical RAM unit would therefore include both military and civilian personnel, numbering 18 highly skilled experts in such areas as airframe repair and electrical work. (20)

Even as AFLC was putting the finishing touches on this plan, the command received an urgent request from PACAF for maintenance assistance on two crash-damaged F-105s. AFLC responded on 22 April 1965 by dispatching a team of 18 civilians to Tan Son Nhut airport, Vietnam. This marked the start of a five-year effort that proved eminently successful but was not without its rough spots. The program had hardly been established when the logistics command realized that if it went unchecked, this new venture might disperse scarce depot maintenance resources. To prevent that possibility, General Hobson instructed his field commanders in August 1965 to limit the RAM program to what was absolutely necessary. AFLC would help, but not at the expense of its worldwide mission. (21)

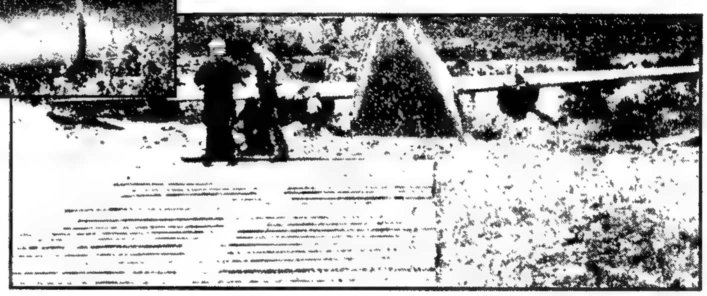
In some respects, the deployment of the RAM teams resembled that of the RASS teams; domestic arrangements were much the same, and like their RASS counterparts, RAM personnel were not reluctant to inveigh against inadequate quarters. In theory, however, what distinguished the personal life of a RAM member from that of a RASS person was the element of danger. While RASS teams mostly confined their activities to major bases, RAM teams often went out to damaged aircraft in the field, where they were subject to ambush. The RAM teams did in fact incur casualties, ironically not in the field but in public places where anybody could have been attacked. The most notable and certainly tragic such incident occurred on the Saigon waterfront on 25 June 1965, when a terrorist bomb killed four RAM men and seriously wounded a fifth. Killed were Leon Forcum, Leo D. Nelson, John M. Kilzer, and Floyd R. McKinney; the wounded man was Alfred H. Charmaza. All five were from the Sacramento Air Materiel Area and were among the first of the RAM men to serve in Vietnam. They were also the first Department of Defense civilians to become casualties of enemy action—but not the last. Fourteen months later, in August 1966, the Viet Cong threw several hand grenades into the noncommissioned officers' club at Da Nang, wounding two RAM personnel. (22)

In addition to personal danger and austere living conditions, the RAM teams had to contend with three large obstacles. The first was the lack of spare parts with which to repair damaged

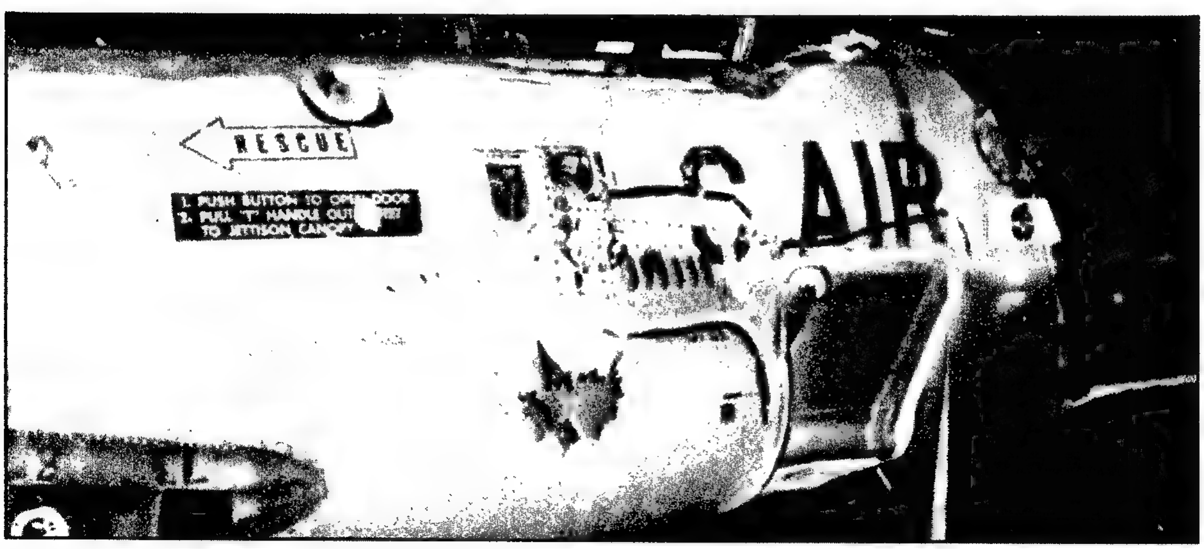


AFLC supply and transportation support team #15 at Tan Son Nhut Air Base in the spring of 1967.

AFLC maintenance personnel reassembling aircraft at Bien Hoa Air Base in South Vietnam.



An AFLC maintenance team working on a crash damaged C-123 in Southeast Asia.



This T-33 training hulk is being repaired by aircraft battle damage repair technicians from the 2952d Combat Logistics Support Squadron at Hill AFB.

aircraft. This problem was complicated by the very nature of the RAM mission, for repairing crash- and battle-damaged aircraft was an unprogrammed activity, which meant that the teams could not control their workload. Nor could they place certain large items in reserve, such as wings or bulkheads, for there was no way to determine future needs. The result was that the RAM teams depended heavily on a pipeline extending 10,000 miles back to depots in the United States. But the length of the pipeline alone did not account for the lack of parts; that lack could also be laid at the door of the system managers and item managers who had not stocked supplies in sufficient quantities for wartime needs. Once the existing stock had been used up—and that happened fast in wartime—new supplies had to be manufactured, which took time and caused delays in repair. The second obstacle was the lack of transportation within the war zone. Although the RAM teams were assigned a high transportation priority, so was most everyone else, and in practice, RAM personnel and their equipment took second place to guns and combat troops. The third obstacle was lack of communications. With limited communications facilities and few telephones and telephone lines, the RAM men had to resign themselves to long delays in placing calls. (23)

These obstacles made the job of the RAM teams more difficult but did not prevent them from carrying out their mission, which was primarily to repair damaged aircraft and, on occasion, to perform other types of depot work. For example, when minor cracks were discovered on the wings of an F-4C, a RAM team that happened to be nearby repaired the cracks and also gave on-the-job training to squadron maintenance personnel. In this instance, such initiative was more likely to have elicited congratulations than objections, but in general, the extent, if not the nature, of the RAM mission was a continuing question throughout the life of the program. It was implicit in AFLC's policy not to create in the RAM teams a permanent mobile depot in Southeast Asia; they were an emergency force to be used only for the short term. On the other hand, the logistics command fully intended to help as much as possible in the repair of damaged aircraft, and sometimes the distinction between the two imperatives was hard to discern. When a RAM team was tasked with the repair of a particular aircraft, the first step for the team leader was to determine whether his team was capable of doing the job. If not, the team would try to prepare the plane for a one-time flight to a contractor in the Pacific theater or to a depot in the United States. (24)

Such was the theory, but on-the-spot judgements and the changing circumstances of war sometimes made it difficult to put theory into practice. By December 1966, for example, General Hobson was worried that his RAM teams were taking too long to repair aircraft, and so he told his commanders that repair of aircraft damaged overseas should be performed as much as possible in US depots. In effect the RAM teams were to be limited to preparing damaged aircraft for flight to a repair facility. But as the war dragged on, that policy was never fully implemented, and in February 1968, just after the Tet Offensive, General Gerrity reaffirmed that the role of the RAM teams was more important than ever. (25)

General Gerrity's faith in the RAM teams was well-founded. What these teams accomplished in Southeast Asia is usually expressed in statistics, and indeed they are impressive. In just their first 20 months, between April 1965 and December 1966, RAM personnel repaired on site and returned to operation more than seven out of ten damaged aircraft. By 1971, when their activities in the Far East had virtually ended, the RAM teams had completely repaired in the field more than 1,000 aircraft, had prepared over 200 aircraft for shipment or one-time flight to a repair center, and had salvaged parts of more than 30 aircraft damaged beyond repair. It is hard to estimate the value of all the aircraft repaired or salvaged by the RAM teams, but one estimate made in late 1969 is revealing: at that time Air Force officials calculated that the acquisition value of the aircraft repaired or salvaged thus far exceeded $1.7 billion. (26)

The Combat Logistics Support Squadrons

At the height of RASS and RAM operations in Southeast Asia, AFLC began laying the groundwork for a permanent solution to what the command considered the most serious flaw in its use of special teams—near total reliance on civilian manpower. By June 1967, the logistics command had drawn up a plan to create a new, all-military organization, the Combat Logistics Support Squadron (CLSS), which ultimately would replace the RASS, RAM, and RATS teams. The plan called for establishing one squadron at each of the five air materiel areas to make a total force of almost 1,200 military personnel. AFLC would furnish over half this number, and presumably the balance would come from other organizations in the Air Force. (27)

In September 1967, HQ USAF approved most of AFLC's plan, and in December of that year the five squadrons were officially established. In the months following their activation, AFLC leaders were anxious to prepare these units for early deployment. General Gerrity, for one, even wanted to accelerate the schedule for achieving operational readiness, originally targeted for October 1968. (His reasons had as much to do with the Korean crisis, involving the seizure of the US Navy ship Pueblo, as they did with the Vietnam war.) And by April 1968, General Jack G. Merrell, recently appointed as General Gerrity's successor, was convinced that his logistics squadrons, if not operationally ready in a technical sense, had at least gone a long way towards that goal. He believed that each of the air materiel areas had "in being" a CLSS "that can replace civilians with similar skills" and that these squadrons would achieve full military capability by July 1968—only three months away. (28)

That assertion was optimistic, for over the next many months the logistics command learned that it would take years, not weeks, before these new units would be ready to perform up to expectations. Hard questions and pessimistic appraisals probably trickled in slowly at first, but in the winter of 1969 they became a flood. In those winter months, management analysts from HQ AFLC traveled to the air materiel areas for a first-hand look at the condition of the CLSS units, and what they found was on the whole discouraging. The squadron at Sacramento, for example, was authorized one major and three captains, but in fact had only four first lieutenants, none of whom had more than two years' service. Worst of all, the Sacramento squadron's maintenance technicians were working mainly on modification projects instead of damage repair, primarily because they lacked the numbers and the skills to do the more complicated work. The result of course was that this squadron was far from proficient in crash and battle damage repair. (29)

The Sacramento CLSS was neither unique nor especially deficient in comparison to the units at the other air materiel areas. They all had their problems. The CLSS at San Antonio, for example, spent most of its time on the B-52, and although that certainly was San Antonio's primary mission assignment, most of the workload in Vietnam involved fighter aircraft. From this and other evidence, HQ AFLC analysts concluded that the command's CLSS program suffered from two main flaws: (1) the lack of a rational system for determining work priorties, and

(2) skill deficiencies among CLSS personnel. This latter failing, the analysts warned, would undermine the ability of the squadrons to carry out their mission. (30)

In the aftermath of this first examination of the Combat Logistics Support Squadrons, the AFLC chief of staff, Major General Melvin F. McNickle, reminded AFLC field commanders that

> It has always been our intent that these units become a highly skilled, elite military force capable of carrying out the AFLC mission. It follows, therefore, that they must receive the best training and utilization possible when at their home station. These squadrons must be given meaningful work that will further enhance their capabilities when they are performing in their prime area assistance role. Specifically, they should be involved in project work such as Time Compliance Technical Order (TCTO) prototyping, Modifications, and Crash-Battle damage repair. It is further requested that the squadrons be utilized as a unit insofar as possible. (31)

This letter spelled out AFLC's expectations, but it was not enough to breathe life into the CLSS. Six months later, in September 1969, the logistics command tried a new approach by appointing a special group to examine all five squadrons with respect to their mission, organization, employment, the reason for their establishment, and possible alternatives to the existing arrangement. After considerable study, the task group reaffirmed the need for a military organization of this kind and agreed that the existing arrangement was the most appropriate. The task group also concluded, however, that the CLSSs had not been utilized as originally planned and that the air materiel areas had failed to make wise use of their logistics squadrons when stationed at the home base. In response to these findings, General McNickle directed the field commanders to reshape their CLSS units "to reflect those skills normally required." He also announced that CLSS personnel would be placed under the direct control of the AMA directors of maintenance and directors of supply and transportation so as to give "adequate and meaningful work and on-the-job training" to the logistics squadrons. These measures were without doubt aimed in the right direction, but they came too late to have a significant impact during the Vietnam era. (32)

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The Role of Packaging in the Military

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The American Heritage Dictionary of the English Language defines logistics as "the procurement, distribution, maintenance, and replacement of materiel and personnel." The DOD logistics system is much more than this. In addition to the procurement, distribution, maintenance, and replacement of materiel and personnel, the DOD logistics system also includes, but is not limited to, the disciplines of packaging, handling, shipping, storage, and transportation. Its primary mission is to provide the soldier, sailor, and airman, the ultimate users, with what they need, when they need it, and where they need it, and to provide it in a usable configuration and condition.

The role of packaging is to afford protection against physical damage and environmentally induced deterioration. Packaging must provide this protection within a context of unknown and varied conditions which exist in the handling, storage, and transportation network. Packaging design must facilitate these handling, storage, and transportation conditions and must provide for a means of inspecting and maintaining the materiel while it is in storage. Packaging personnel must be responsible for the safety, health, and environmental impact of their decisions. They must be responsive to the needs and concerns of society as well as to the needs and concerns of the military personnel they serve.

All of this makes packaging sound pretty important, doesn't it? Well, the truth is that packaging is vitally important. It is an essential element in the logistician's periodic table. If one of the other logistical elements fail, such as shipping or storage, the serviceman can still function for an extended period of time. However, if the element of packaging fails, he may not be able to function at all. What would a tank crew member do if he found that his gun tube barrel was corroded because someone failed to apply the required preservatives? Or what would someone do if he couldn't get a canteen of drinking water because someone failed to properly preserve or pack the water purification equipment? Many more examples could be cited, but they would all invariably have a negative result.

The bottom line is that even though packaging is vitally important to our success, most of us take it for granted. We don't think about it until something is received broken or corroded or just doesn't work. Then we'll blame anyone within shouting distance. In the past, packaging was considered by many to be merely something that was nice to have but was not considered to be mission essential. If a commander had extra money to spend, he would rather buy an additional squad tent or extra field tables than buy a heat sealer or a pallet load of fiberboard boxes. Maybe that was okay 10 years ago, but it's not okay now.

As the terms "downsizing, drawdown, reorganizing, and base closure" become part of our everyday lexicon, we are faced with the reality of having to do more with less. This realization is never more evident than in the field of packaging. The dollar value of materiel returned from Desert Shield/Desert Storm that was ruined because of improper or inadequate packaging protection may run into the hundreds of millions of dollars. Recent studies have shown that depot-level reparable materiel being returned for repair has often been damaged or degraded as a result of improper or inadequate packaging or processing. Because of packaging's vital role in our everyday operations, military and civilian DOD personnel who process and pack materiel must be sufficiently trained if this negative trend is to be reversed.

Packaging personnel often find themselves in a Catch 22 situation. They may possess the necessary packaging skills, but do not have the packaging materials and equipment required to perform their packaging duties. Or they may have the required packaging materials and equipment, but do not possess the necessary packaging skills to perform a packaging function. The most important commodity in DOD's packaging community is its people. It takes people to perform the packaging mission. The most sophisticated equipment in the world is worthless if no one is properly trained to operate it.

With DOD's implementation of the Stock Funding of Depot-Level Reparables (SFDLR) Program, packaging in the military has never been more important, and the need for additional, in-depth, formal packaging training at all levels has never been more paramount. Under the SFDLR Program, units will receive a percentage of credit when they turn in serviceable and unserviceable materiel. The amount of credit received will be predicated on the condition of the materiel when it arrives at the servicing depot. When the SFDLR is fully implemented, the careless identification, packaging, and transporting of reparables will directly cost units from their stock funds. That's why it is imperative that all military and civilian personnel, who perform a packaging function, receive some type of formal packaging training.

In our continued efforts to do more with less, we must better utilize our resources, including our personnel. As the DOD moves toward a smaller, quicker, more mobile military, and as the role of packaging becomes more critical to its success, the need for trained packaging personnel has never been greater. We must now make the funds available for formal packaging training at all levels. We cannot wait for later. LATER IS NOW!

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